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THE NEW YORK RAPID-TRANSIT SUBWAY.

By H. C. Fyfe.

The New York rapid-transit subway, which is just on the eve of being opened to the public, is notable not only as the largest system of the kind ever undertaken, but further as the one which has been most opposed by difficulties of construction. Local geology and existing conditions in the streets, above ground and below, beset the work with delays and obstacles. The details of the auxiliary and collateral works, needed to clear the ground for the main undertaking, bristled with vexatious problems. The solution has been reached through the liberal outlay of money by the city, and the courage, ingenuity, and skill of those in actual charge of the construction.

The following pages, in text and engravings, give a clear and comprehensive review of the entire work. Mr. Fyfe died in March last, before the article had been put into type. We are indebted to the office of William Barclay Parsons, Esq., chief engineer to the Rapid Transit Commissioners, for the official maps and many of the photographs, and especially to George S. Rice, Esq., deputy chief engineer of the Rapid Transit Commission, and John Van Vleck, Esq., mechanical engineer of the Interborough Company, for revising Mr. Fyfe's proofs and bringing the account up to date in complete accuracy.—THE EDITORS.

THE New York Rapid Transit Subway, a portion of which will be opened for travel this month, has a very special interest in that it is the only sub-surface railway which has four tracks, two for local and two for express trains. It is also noteworthy in that portions are in a shallow subway and portions on an elevated structure, and in this it resembles the new Berlin Combined Elevated and Underground Railway, which was described in these pages last month.

In the case of London, the fact that the substratum of the Thames valley under the metropolis is composed of "London clay," with no rock or gravel, renders the work of tube construction both easy and rapid. The water lying in the gravel above the clay cannot permeate

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through the latter. But New York is built mainly upon rock, with some deep pockets of sand, and therefore the task of making a railway below the surface is one of great expense and difficulty.

The land on which New York is built was bought by Peter Minuit in 1626 for $24. In 1653 it had a population of 1,120; in 1731 of 8,256; in 1800 of 60,489; in 1850 of 515,547, while in 1900 Greater New York had a population of 3,437,202.

As far back as the middle of the last century, the pressure of necessity for rapid-transit facilities which could keep pace with this fast-growing population began to make itself felt. For a time the street railways were the only answer offered to the problem. The elevated railways, built against much opposition under the Rapid Transit Act of 1875, promised for a time to cope with the conditions; but their insufficiency soon became apparent, and in spite of every effort to increase their carrying capacity—even the recent change from steam to electric power—they have steadily fallen further and further behind the demands put upon them. What the rate of increase of these demands has been is best indicated by the figures of the north-and-south travel—the principal component of the total city traffic, and the only one directly affected by the additional facilities afforded by the subway we are reviewing. These figures were, for 1892, 391,000,000; for 1896, 440,000,000; for 1899, 553,000,000, and for 1902, 627,000,000. Rapid-transit legislation was passed, and commissions were appointed in 1890 and 1891; but no definite project was actually advanced to the stage of construction until the present commission, appointed in 1894, had been in office for some years. The general outlines of the scheme were settled in 1897, and the plans submitted to bidders and the contracts let in 1900.

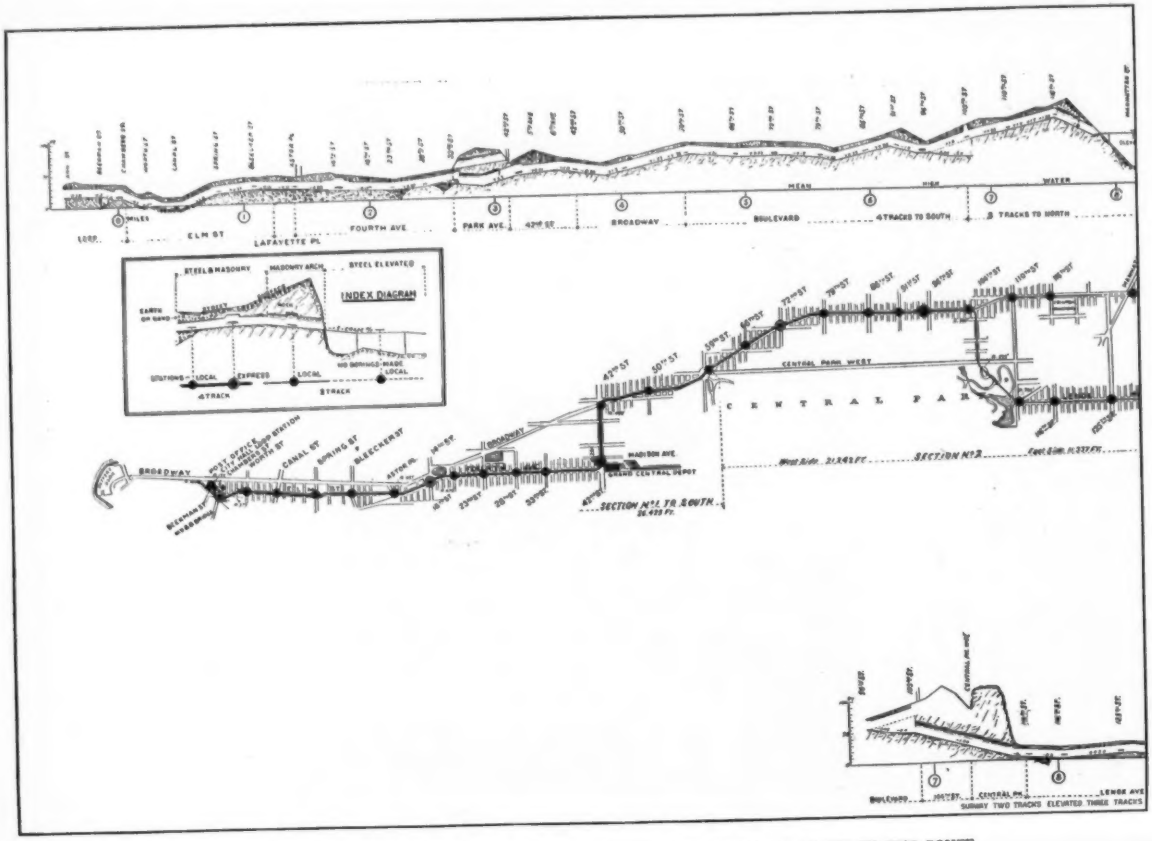
Before deciding upon the main outlines of the project, the commission went thoroughly into the question of shallow subways and deep tunnels, finally deciding on the former type of construction. Each, of course, has its own peculiar advantages and disadvantages; but it must be remembered that on account of its peculiar shape, New York can spread only in one direction, and therefore on its main lines of communication there is a congestion of traffic far exceeding that to be found in any other city of the world. This being so, it is evident that no system of elevators could be installed at reasonable expense to cope with the enormous number of passengers at certain stations along the route. The commission reported that for a rapid-transit system to fulfil the first object of its existence, it must be close to the surface and be accessible without the use of elevators.

The vote of the people sanctioning the plan of municipal ownership having been obtained, the commission proceeded to the question of the route, and after much litigation the following was the one originally decided upon. It was to begin with a loop at the Post Office; thence with four tracks it goes direct to the Grand Central Station, in Forty-second street, thence westerly to Broadway and along that thoroughfare to One Hundred and Fourth street, a distance of seven miles; here the four tracks divide; one double-track and three-track line continues along Broadway to Kingsbridge, while another double-track line crosses under the Harlem River and proceeds

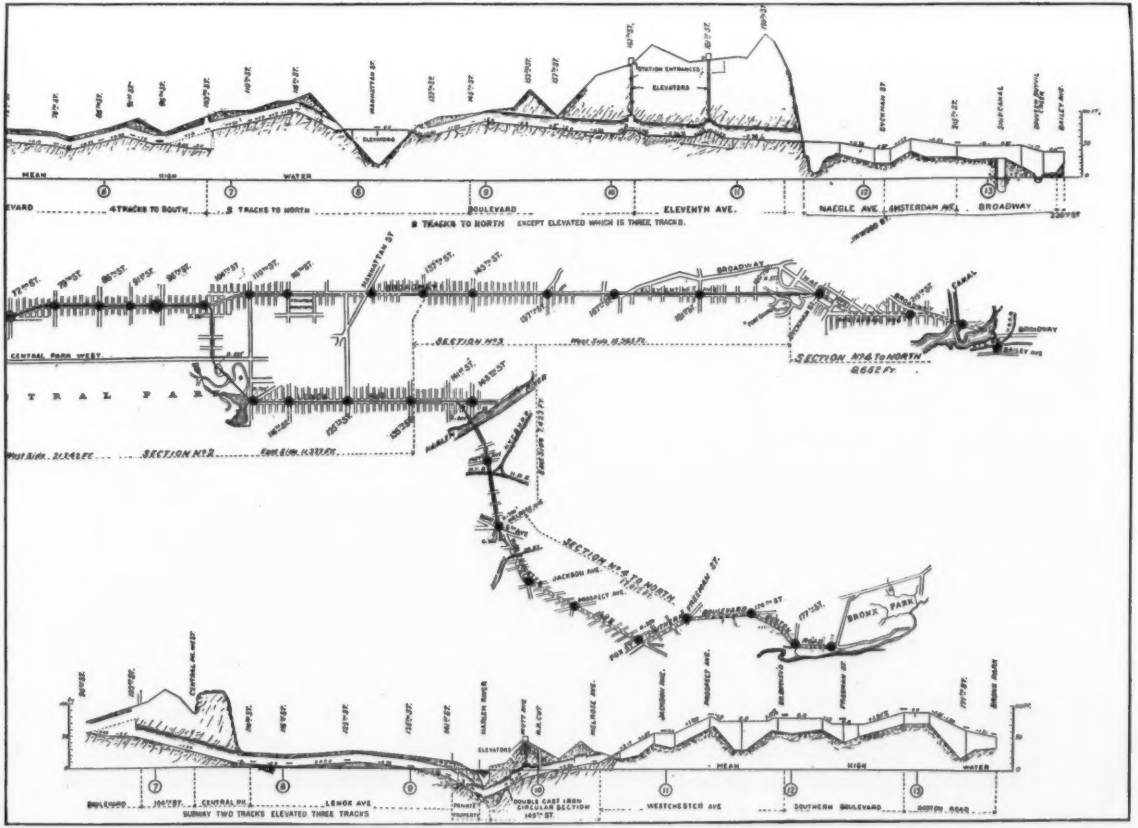
THE CITY HALL LOOP—DOWNTOWN STARTING POINT OF THE FIRST SUBWAY CONTRACT.

to Bronx Park and the Zoological Gardens over a three-track viaduct; each of these branches is 7 miles long, or a total length for the whole system of 21 miles. The northerly ends of the three-track lines are to be elevated structures for a combined distance of 7.14 miles, and there will also be a short length of high steel viaduct ½ mile long crossing Manhattan Valley, an abrupt depression on the west side. All the remainder will be underground.

For the first 7 miles there will be four tracks; on the center pair trains will be run at all hours of the day in both directions, stopping at stations about 1½ miles apart and making a speed of at least 30



OFFICIAL MAP OF THE NEW YORK SUBWAY, SHOWING THE SOUTHERN PART OF THE ROUTE.



OFFICIAL MAP OF THE NEW YORK SUBWAY, SHOWING THE NORTHERN PART OF THE ROUTE.
The map partially overlaps that on page 884.

CUT-AND-COVER WORK IN A BUSY STREET—ABOVE AND BELOW GROUND.

The upper view shows the surface of Fourth Avenue, at Madison Square Garden. The lower is taken underground, at almost the same spot and date.

miles an hour; on the outer pair of tracks stations will be at much closer intervals, averaging four to the mile, the trains on these tracks attaining a speed of about 14 to 18 miles an hour including stops.

There will be two types of station—one a local station with platforms on the outside of the outer tracks and center tracks on which the express trains pass through without stopping. At the other type all trains stop, both express and local; at these stations a partial departure is made from the principle of adhering closely to the grade of the street, the whole railway being depressed sufficiently to permit the construction of a bridge over the four tracks, but of course *under* the street surface, connected with all four platforms by convenient stairways. If a passenger wishes to travel to a station where the expresses do not stop, he would leave the fast train at the station nearest to his destination and take a local train on.

Practically the whole of the subway lies immediately beneath the double tracks of the busiest electric surface lines and under some of the principal arteries of vehicular traffic. One of the conditions imposed upon the contractors was that there must be no interference whatever with the operation of the electric cars and the least possible obstruction to ordinary street traffic. It will be readily seen that the problem of carrying the electric tracks while the solid ground beneath them was being cut away was a very difficult one, and the means adopted for supporting the trolley tracks, and also the great mass of gas, water, electric and other mains while the earth and rock were being excavated, the steel built in place, and the concrete covering and the back filling and surface filling put in, deserve special notice.

In Park Row, for instance, the whole roadway was undermined without stoppage of the traffic, although there were four tracks of conduit electric cars on the surface and the sub-soil was entirely sand.

Advocates of the shallow subway pointed out that one of its chief advantages lies in the fact that all pipes, cables, mains, etc., can be re-laid in special galleries, thus avoiding the continual tearing up of the streets. When the New York subway was decided upon, it was realized by the engineers that there was a great opportunity for gathering all the city mains, conduits, cables, etc., together, and placing them in galleries constructed at the side of the rapid-transit tunnel. Plans were drawn for these galleries, and they were so arranged, with proper manhole openings at intervals, that whenever any repairs, laying of mains, or making connections to buildings had to be done, the gallery could be entered at the proper manhole and the work carried out without any disturbance whatever of the city streets. On

THE BEGINNING OF A SECTION OF CUT-AND-COVER WORK.
Showing the cableways at work removing the surface of the street.

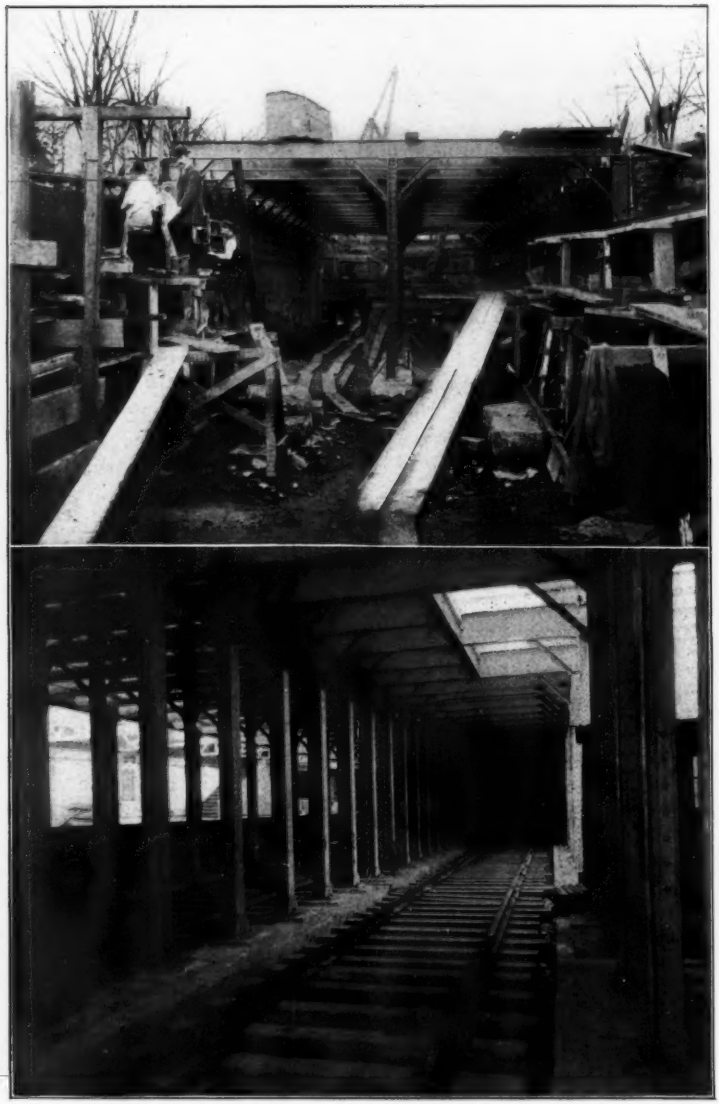
some stretches of the subway, excavation was made for these galleries; but owing to questionable moves on the part of the politicians who were in power at that time, two or three heads of departments raised a series of obviously absurd and inadequate objections to the plan, with the result that the rapid-transit commission, rather than become involved in a legal controversy that might seriously delay the work, decided to go ahead with the tunnel and drop the gallery scheme altogether. As a consequence the city mains have been spread over the roof of the tunnel, some distance below the surface of the ground, and it is pointed out that the city will continue to be exposed to the same interminable interruptions of traffic, which will be all the more exasperating because they could easily and cheaply have been avoided. Plans have been prepared for pipe galleries along the Broadway line leading to the Brooklyn tunnel. It is hoped that the city may be able to furnish the money necessary for the construction of these galleries.

Method of Construction.—The completed subway forms a steel structure rectangular in shape and built in an open tunnel.

The first step in its construction, throughout the greater part of its length, was to tear up the surface of the street and excavate it to the depth required, which averages about 20 feet. Then there was spread upon the bottom of the excavation a solid floor of concrete, and on this floor there were erected at intervals of about 5 feet, running transversely to the line of the street, frames of steel beams securely riveted together. These frames were to the structure what ribs are to the body, and they are designed to take up the load of the street and the thrust of the side earth. Between these frames or ribs there is built a concrete wall and a concrete roof, and between the tracks supporting the roof there are rows of light steel columns.

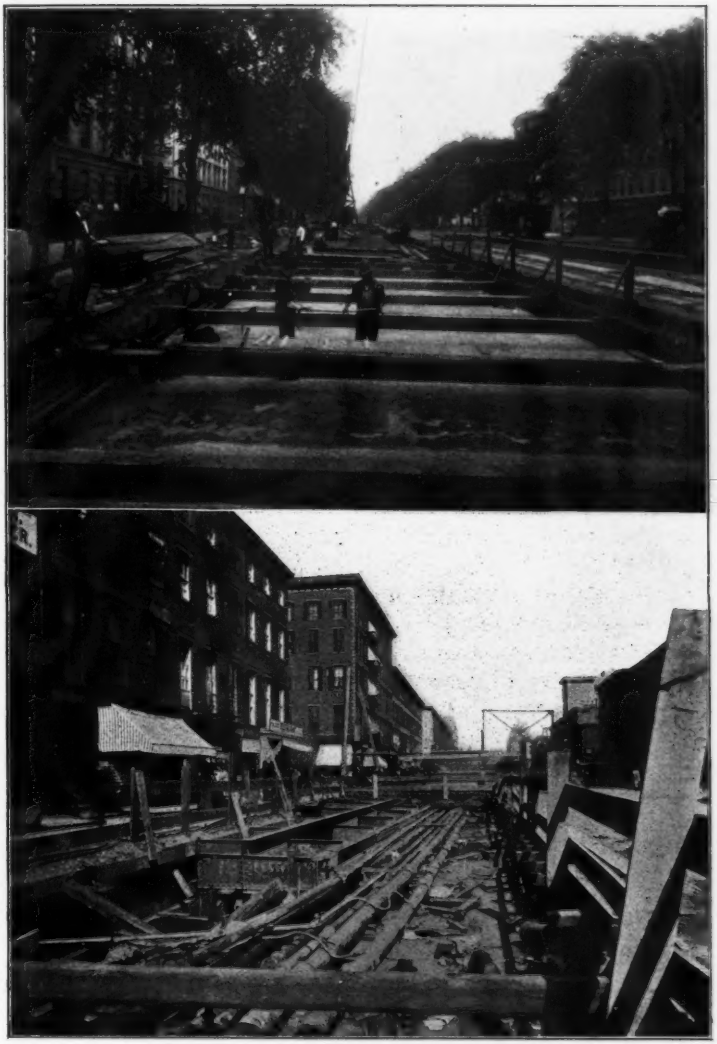
> "Sunlight during the day," says Mr. Parsons, "will have full play in the stations, lined as they will be with decorated tile, and with the railway in front with a flat roof the whole structure will suggest to the traveller what it is, in fact, a covered way. There being no smoke or combustion-producing motors the railway will be entirely free from obnoxious vapors; and as the stations will be at short intervals, and with large openings to the outside, there will be nothing of the nature of a close confined space, and therefore nothing giving the sensation of what is popularly known as 'cellar air.'"

The construction of the subway beneath Broadway will be, in general, similar to that employed on the rest of Manhattan Island, which may be described as a floor of concrete, with side walls and roof consisting of I-beams with concrete arches turned in between them, the



SUCCESSIVE STAGES IN CONSTRUCTION OF THE NORMAL SUBWAY.

In the upper picture, work is proceeding toward the background. In the middle distance the steel framework is completed and the arches turned between the verticals. The lower view shows the completed structure at a local station.



SECTIONS OF THE CUT-AND-COVER WORK APPROACHING COMPLETION.

The upper view shows the roof of a finished section, seen from above, before the final filling in. In the lower picture a similar roof is shown with the various mains systematically relaid upon it, nearly ready for covering.

roof being supported on built-up steel columns, and the whole tunnel rendered waterproof by a complete envelope of waterproof felt put down in layers and thoroughly coated with tar. For the roof of the Broadway tunnel, however, a new system of construction, which has lately been adopted for the Lenox Avenue section of the road, will be used. This is what is known as reinforced concrete, the roof consisting of a mass of concrete with 1¼-inch square steel bars imbedded near its under and upper surface, the bars extending transversely across the tunnel and serving to give the necessary tensional strength to the concrete roof. This system of construction is more rapid and considerably cheaper than the old method of using transverse I-beams with concrete arches between them. The vertical I-beams of the side walls will be retained in building the road down Broadway, as they will prove valuable in affording lateral support for the careful shoring, which must be done in taking care of the foundations of adjacent lofty buildings during the process of excavation.

Supporting the Electric Tracks.—At the level of the street surface two pairs of 24-inch I-beams, 2 feet in depth and about 35 feet in length, were placed parallel with the tracks, one pair on each side

FIVE-TRACK EXCAVATION IN A ROCK CUT ON THE EAST SIDE OF UNION SQUARE, SHOWING THE CHARACTER OF THE GROUND UNDERLYING MOST OF THE CITY.

TRUSS CARRYING THE TROLLEY LINE, USED ON THE BOULEVARD WORK.
These trusses were moved forward as the construction advanced.

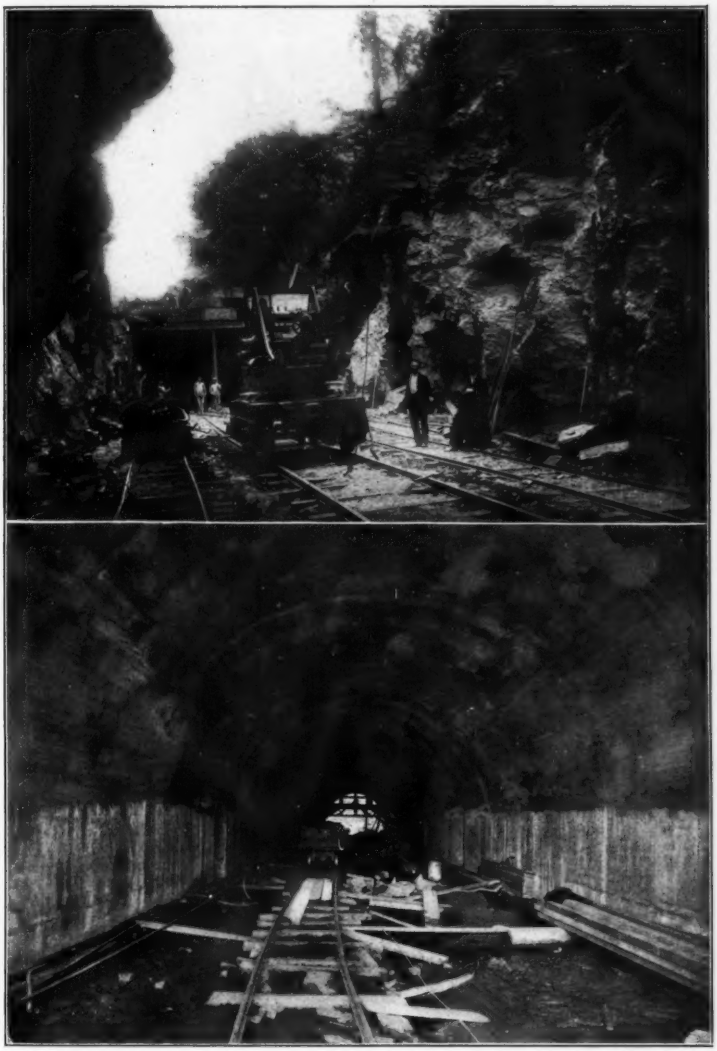
thereof. At each end of the I-beams, 12 by 12 posts were sunk to a firm foundation, and for the length of track covered by the I-beams the soil beneath the yokes carrying the tracks was dug out, and 12 by 12 timbers placed underneath them crosswise to the track. Heavy bolts were then passed up from the ends of the transverse timbers to the top flanges of the I-beams and drawn up snugly by nuts, the load of this stretch of track with the cars upon it being thus transferred to the I-beams. Similarly, 12 by 12 supporting timbers were placed from the I-beams to the adjoining sidewalks on either side, one end being bolted to the I-beams and the other resting upon the sidewalk flagging. The material was then excavated by pick and shovel, dumped into buckets of an overhead cableway, loaded into carts, and taken to some convenient dumping ground. The timbers extending from the I-beams to the sidewalks served to hold in place and carry during the progress of excavation the numerous water, gas, and electric mains, which lie immediately below the surface of the street. These were slung from the beams by stout chains, which held them securely in their proper level and alignment during the work of ex-

cavating. As the excavation was carried down, additional and longer 12 by 12 posts were put in place until sub-grade was reached. The foundation blocks and concrete floor were laid and the steel columns and the I-beams of the roof erected, the side walls and the intervening arches of concrete built in place, and the back filling rammed in, completing the work. As this filling was brought up to grade, the chains supporting the gas and water mains were unslung and the 12 by 12 timbers removed, the surface of the street being finally restored to its original condition. The steel framing is spaced about 5 feet apart longitudinally and answers in some sense to the framing ribs of a modern steamship. The concreting between the side-posts and between the I-beams of the roof is built in arched form to enable it better to resist the crushing pressure to which it is subjected.

Of the total length of subway now completed about half has involved the opening up of the streets; some four miles of deep tunnel work has been carried on without any considerable obstruction of the surface, while the remainder is an elevated structure. The "cut-and-cover method" (and New Yorkers say there is a great deal of cut and very little cover) involves the excavation of the tunnel, the erection of the steel framework, the building of the concrete roof and brick or terra-cotta sidewalks, the filling in of the excavation, and the paving or asphalting of the street surface.

Deep-Level Tunnels.—Of the deep-level tunnels that are being excavated entirely through rock, there are three principal sections. The first of these is the double tunnel, with two tracks in each, extending from Thirty-fourth Street to Forty-second Street. The next section of deep tunnel is that which runs under Washington Heights between One Hundred and Forty-fifth Street and the station at One Hundred and Sixtieth Street. The last section is between One Hundred and Sixty-first Street and One Hundred and Ninety-sixth Street.

Harlem River Tunnel.—The subway is carried under the Harlem River in a two-track tunnel. The method used in the present case was to drive two lines of sheet piling parallel with the line of the tunnel, and wide enough to enclose it; to construct a strong roof of timber across from wall to wall of piling; and then, by means of pneumatic pressure and air locks, exclude the water and excavate the soft mud from within the tunnel caisson and build the tunnel structure, which is constructed, part of it of concrete and part of it of cast iron, within the working chamber thus provided. The construction of the caisson involved the driving of piling throughout the full

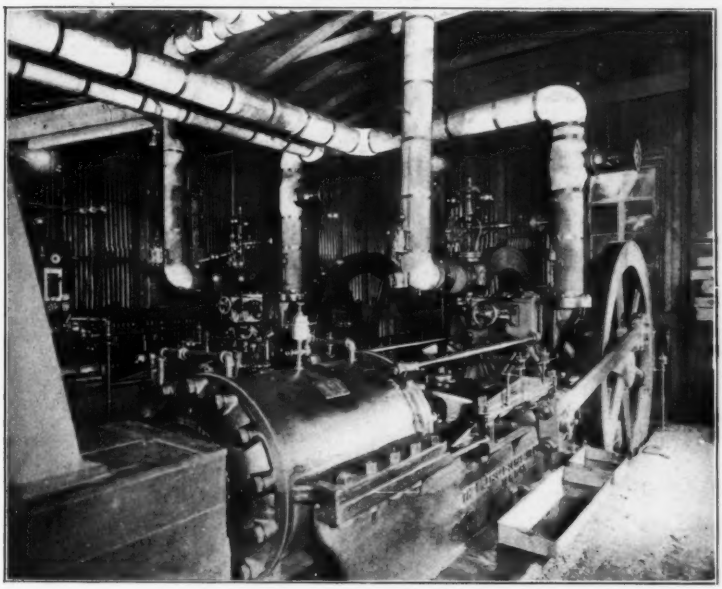


TUNNEL SECTIONS. THE UPPER VIEW IS AT THE PORTAL, ON THE NORTH OF CENTRAL PARK. THE LOWER IS IN THE TUNNEL ON UPPER BROADWAY.

CUT-AND-COVER WORK IN FULL PROGRESS, ON A MINOR STREET.

Elm street, not being one of busy traffic, was given up entirely to the subway work, no effort being made to maintain the surface.

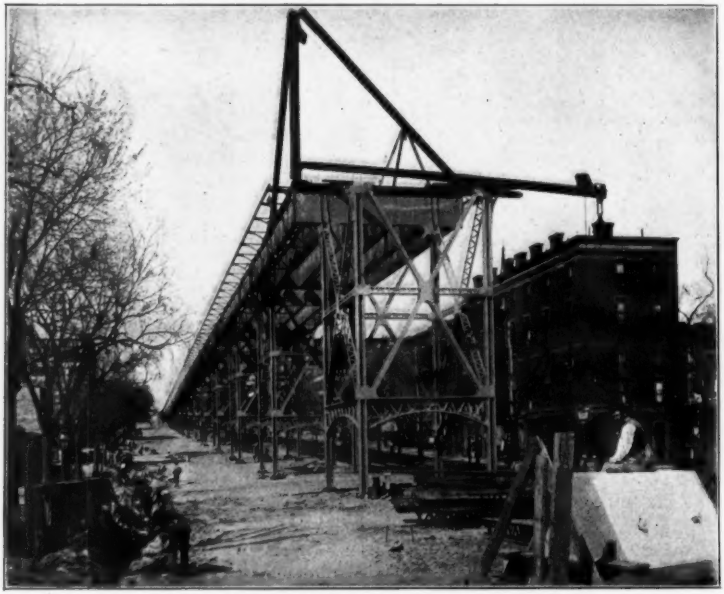
length of the tunnel, and the piling, when cut off before commencing the construction of the tunnel proper, served to give a perfectly unyielding foundation upon which the completed work could rest, thus preventing the possibility of any future settlement.



ONE OF THE MANY POWER PLANTS FOR AIR COMPRESSORS, ETC., USED ALONG THE LINE OF THE EXCAVATION.

Method of Construction.—In carrying out the work, the first step was to dredge out a channel to within about 6 feet of the subgrade of the tunnel. Piling was then driven for two lines of working platform, one on each side of the tunnel. Next the supporting piles for the roof of the caisson were driven, each bent containing four piles, and the bents being spaced eight feet from centre to centre. The duty of these piles was to support temporarily the timber roof, to assist in putting in place the transverse braces that held the side walls in line and to give additional bearing to the finished tunnel. To preserve the two sidewalls of sheet piling accurately in alignment, a pair of continual longitudinal trusses was used for each wall, the two trusses in each pair being spaced 12 inches apart, or the width of the sheet piling wall. To maintain the side trusses with their wall of piling at the proper distance apart, and preserve both walls in true line, a

series of transverse trusses was constructed, which extended from wall to wall and reached almost to a contact with the longitudinal side trusses. With the combination of the longitudinal and transverse trusses with the rigid line of piling, it was possible by the judicious use of wedges at the ends of the transverse trusses to keep the side trusses and therefore the wall of piling very accurately in line. The



A PART OF MANHATTAN VIADUCT, DURING CONSTRUCTION.

grade of the tunnel was also accurately determined by moving the cut-off circular saw upon a track supported on the working platforms, and giving this track the exact pitch or grade required for the tunnel by moving the saw forward and maintaining always the same reach of the saw shaft. The cut-off of the piles necessarily presented the required grade for the finished tunnel.

The remarkable accuracy of the sheet piling and the tightness of the whole work is due very largely to the use of a compound pile which was designed especially for the work. This consists of three 12 by 12 sticks bolted together and driven as one pile, each three-fold pile being tongued and grooved to the next pile; the work was also greatly facilitated by the use of pilot piles, which were built of

SEWER WORK, INCIDENTAL TO THE CONSTRUCTION OF THE SUBWAY.

The upper view shows one of the duplicate sewers, carried each side of the subway wall on certain sections. The lower is a large sewer intersection on One Hundred and Tenth St. The cost of sewer diversion is included in the contract.

TWENTY-THIRD STREET STATION. A POSSIBILITY FOR THE CITY OF THE FUTURE.

The space back of the pillars on the left is the sub-basement of a large office building. These lower stories, along the whole line, can be developed for useful commercial purposes.

steel channels and plates and measured 12 by 12 inches in cross section. These were driven with the aid of the jet, and served to open the way for the wood piling. Moreover, by their use it was possible to detect the location and contour of boulders, and when such boulders were struck, it was only necessary to withdraw the pilot-pile, blast out the obstruction, and drive the wooden pile.

The timber roof was built up of three transverse layers of 12 by 12 timber, and two intermediate layers of two-inch plank. The whole roof was well bolted and caulked, so as to make it water-tight. It was built in sections varying from 40 to 130 feet in length, floated into place between the working platforms, and sunk until it rested upon the top of the sheet pile. The joint between the roof and the sheet piling was closed by T-irons and a very satisfactory air-tight joint was secured. About 5 feet of mud was then dumped upon the roof, to keep it down in place with a firm bearing.

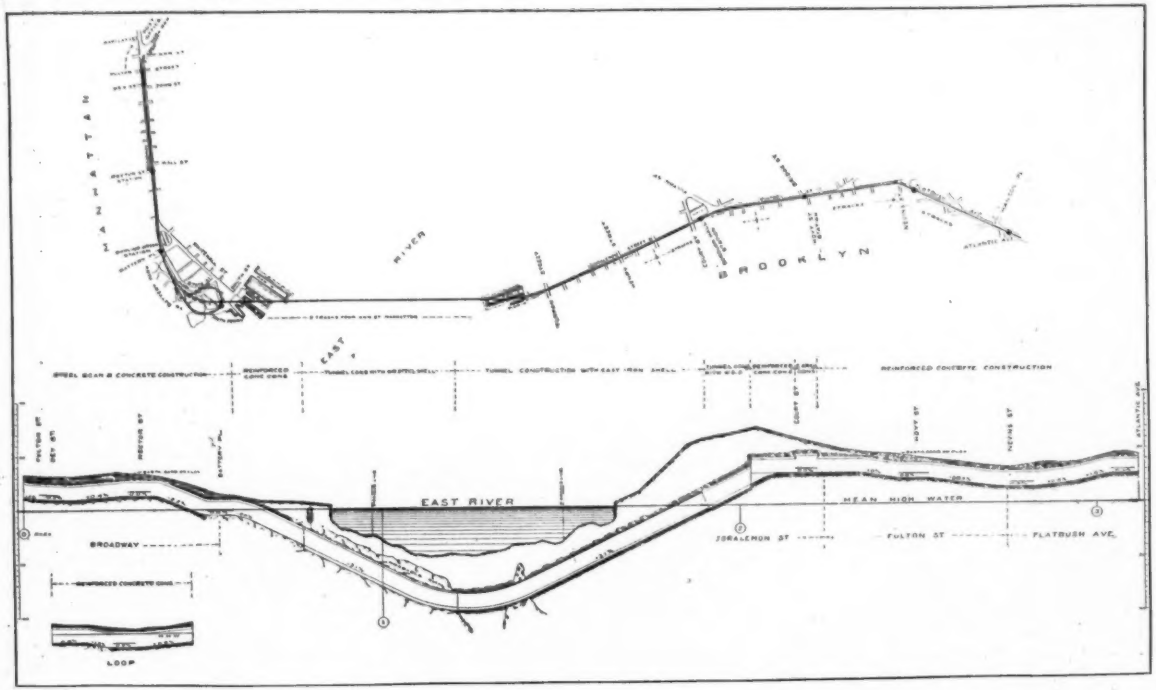
It was necessary to maintain the Harlem River channel navigation during the prosecution of the work, and consequently, only half of the river was closed at one time. This involved the enclosing of the work by two air-tight coffer dams. Near the centre of the roof of the caisson was built up a rectangular timber caisson with the usual air-lock, and in this were placed the pumps for taking out the soft material of excavation. Cylindrical iron material shafts were, of course, provided with the usual air-locks. An air pressure of 10 pounds to the square inch was sufficient for operation.

After the water had been lowered in the working chamber, the work of throwing out the mud and other material proceeded without any difficulties whatever, and when the excavation had been carried down to the desired level, the concreting of the floor was begun and carried up around the head of the piles.

These were then cut off, and spikes were driven into them, so as to give them a good grip upon the concrete foundation. After several feet of concreting had been laid, the cast-iron lining was put in place, the concrete carried up around it, and the tunnel completed. The upper length of the sheet piling was then cut out and the working platforms were removed.

The Harlem River tunnel was carried out by Messrs. McMullen and McBean and thanks are due to Mr. McBean for details supplied.

Brooklyn Extension.—The new section of the subway now under construction from City Hall Park, Manhattan, to Flatbush and Atlantic Avenues, Brooklyn, has been described as in some respects the most important link in the whole rapid-transit subway scheme.



OFFICIAL MAP OF THE EAST RIVER TUNNEL AND THE BROOKLYN EXTENSION OF THE SUBWAY.

As the result of the introduction of a new system of construction for the side walls and roof of the subway, it is expected by the contractors that they will have the new line finished from City Hall Park to the Battery in a very short time. The tunnel beneath the East River will take about three years to construct.

The new extension, which will be a two-track structure, will start from the end of the present subway at the intersection of Park Row with Broadway, and it will extend beneath Broadway to the Battery, where there will be a loop for the use of the Manhattan trains, which will make the return trip to Harlem and beyond. On this portion of the line there will be four stations—at Fulton Street, Rector Street, Bowling Green, and on the loop at South Ferry opposite the Staten Island Ferry terminal. In some particulars the construction of the Broadway line will be similar to that of the subway already built.

The southerly end of the Bowling Green station platform will be located on the west side of State Street, about opposite the center of the new Custom House, and at this point will commence the terminal loop, which will extend below Battery Park. The station will be on the outer side of the loop, and in general will lie opposite the terminal stations of the various ferries that centre at South Ferry. There will be two tracks throughout the loop, the outer of which will be devoted to the through travel, the inner tracks being used for the storage of trains. At the point where the loop commences, the two tracks of the Brooklyn connection will switch off from the Broadway tracks and will be carried under the loop in a separate tunnel, on a descending grade to pass beneath the East River. These tracks will lie in a single tunnel until they approach the South Ferry station, when they will separate and each track will be carried in its own tube until Brooklyn shore is reached, when they will unite again in a single tunnel.

Considered as a transportation center, South Ferry, already an important point, will become one of the most important points of concentration in the world.

The East River tunnel tubes will descend on a grade of 3.1 per cent. until they reach the center of the East River, when they will rise on the same grade to enter Long Island beneath Joralemon Street. In Brooklyn, the subway will pass below Joralemon Street to the Borough Hall, where there will be a station; it will then pass beneath Fulton Street with a station at Hoyt Street, to Flatbush Avenue, where there will be another station, and will continue up Flatbush Avenue to a station at the junction of Flatbush and Atlantic Avenues. The tubes beneath the river will be built in sections of segmental,

WHERE THE SUBWAY EMERGES ONTO THE MANHATTAN VIADUCT.

The upper picture is taken looking north along the viaduct. The lower looks south along Broadway from a point slightly further down, and shows the buildings of the Teachers' College and Columbia University on the left.

heavy, cast-iron plates, with strong internal ribs, the sections being strongly bolted together as construction proceeds, and the completed tube being lined internally with beton, which is filled in flush with the inner edges of the ribs.

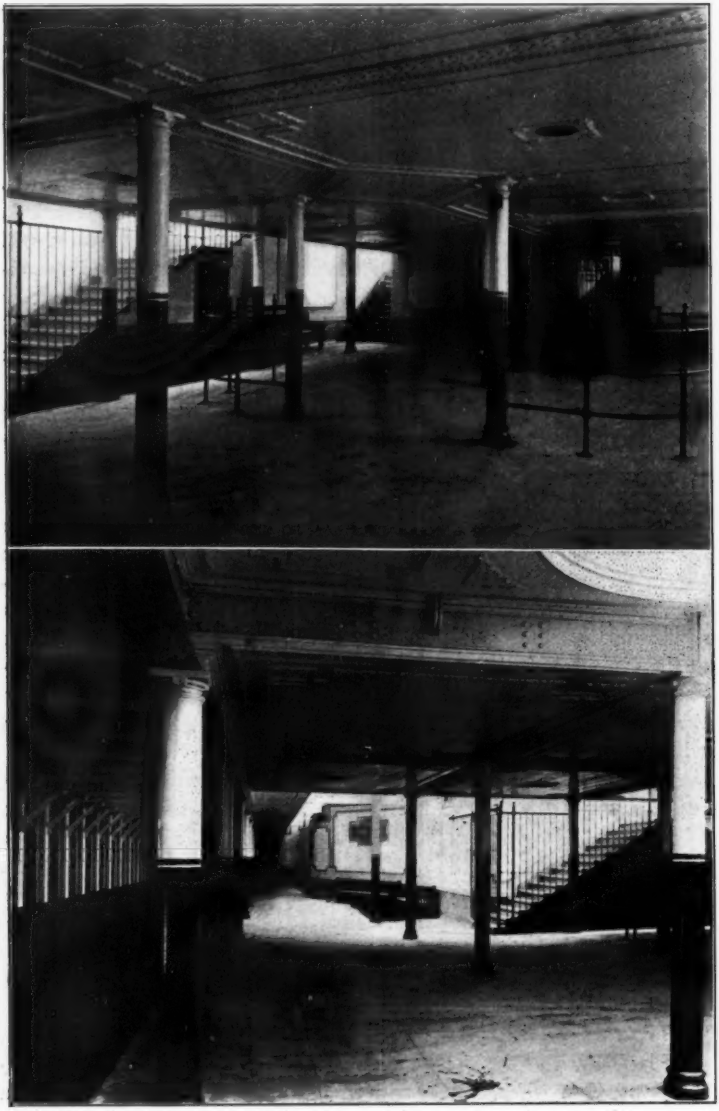
The New York Central and Hudson River Railroad Company can run two connecting tracks from their system at Forty-second Street, to connect with the subway under Fourth Avenue. By this connection the suburban trains of the New York Central, the Harlem, and the New Haven Roads, which are to be operated electrically, will be able to proceed to City Hall Park, or to the Battery, or to Brooklyn, as may be desired, and suburban residents living as far out as Peekskill, White Plains, and Portchester, will be enabled to travel from their respective homes to their places of business in New York or Brooklyn without change of cars.

The contract that was let for lower Broadway specified that the work was not to be commenced until the whole of the necessary structural material was stored in the yards of the contractors either in the City or within easy reach of the work. Not only was the steel to be so stored, but the paving blocks and excavating material, as they are taken up, are to be carted away and stored until such time as the contractors are prepared to restore the streets to their former condition. No derricks are permitted to be erected at street grade, but a platform has been built above the streets, resting on posts placed at the curb line, from which the whole of the work of hoisting excavated material and lowering structural steel, etc., is carried on. While there is a certain measure of inconvenience, it is slight in comparison with that which has attended the work now nearing completion.

A vigorous protest was made against the construction of a tunnel beneath upper Broadway, and the suggestion was made that instead of the "cut and cover" method the railway should be carried in a tube 60 or 80 feet below street level. The suggestion was not agreed to.

Extension of the Subway System.—The maps reproduced on pages 884, 885, and 902 show the principal subway schemes. Should the proposed extensions be carried out, the city will own a complete railway system covering 45 miles in the borough of Manhattan and the Bronx, with 135 miles of track exclusive of side tracks.

The first portion of the subway to be opened will be that from City Hall Park to the great underground storage yards at One Hundred and Forty-fifth Street, and on this part of the work there is a stretch of elevated viaduct which carries the tracks across the Manhattan Valley. The viaduct consists of a single arched span over One



AN EXAMPLE OF STATION INTERIORS. TWO VIEWS ON THE PLATFORM AT TWENTY-EIGHTH STREET.

Hundred and Twenty-fifth Street, measuring 170 feet between the skewbacks, and a trestle approach on either side of it. The connection between the tunnel and the trestle at either end will consist of an open cut and a masonry embankment. The embankment will be faced with stone and brick, and finished with a massive stone parapet of pleasing design.

The stations are of two different types of construction. The City Hall Park station, for instance, is formed of arched concrete construction, while the roof of the Circle station is carried on steel columns and girders with concrete roofing turned in between the girders. In both cases the stations are well lighted by overhead sidewalk vault lights, assisted by a liberal use of incandescent electric lights. The finish of the walls is in glazed tiling, the colors being chiefly white, green, and Venetian red. The names of the stations are shown in large glazed tile letters set in the panels of the wall, and they will be clearly distinguishable by the passengers. The loop tunnel will contain a single track, and the station platform, and indeed, the whole station, is on a curve of somewhat sharp radius. The Circle station, being on the main line, will contain four tracks. An interesting feature of the Circle Station is the fact that the structure cuts in underneath the Columbus statue, which is over 75 feet in height and weighs about 724 tons. During excavation a pair of heavy steel girders was placed beneath the corner of the heavy base of the statue and carried on two temporary timber bents. The steel work was then built in place and concreted up, the temporary girders and bents were removed, and the surface restored to its original condition. To prevent sliding in of the old foundation, a new foundation of rubble was carried down at the side of the subway excavation and left permanently in place when the subway was completed. This monument is shown on the next page.

The Power House.—The great power house is situated on the Hudson River between Fifty-eighth and Fifty-ninth Streets and Eleventh and Twelfth Avenues. Nine 8,000-horse-power engines, direct-connected to 5,000-kilowatt generators, will form the initial equipment, the power-house property being large enough to admit of additions as there shall be a demand for them. About six hundred cars will be called for at the opening of the line. The specifications called for a multiple-control system, three cars out of five, or five cars out of seven or eight in a train, being motor cars. A contract was let to the Pennsylvania Steel Company for 10,000 tons of rail, weighing 100 pounds to the yard.

The power-house building covers a plot of ground 200 feet in width

THE EXCAVATION ON BROADWAY, LOOKING NORTH FROM THE CIRCLE. THE FOUNDATION OF THE COLUMBUS MONUMENT, IN THE FOREGROUND, WAS PARTLY UNDERCUT AND REBUILT TO ACCOMMODATE THE SUBWAY CONSTRUCTION.

by 700 feet in length. A fair idea of its size is gathered when it is stated that it is nearly twice as large as Madison Square Garden. By the time it is fully equipped, it is estimated that its cost will have reached $7,000,000. When the complete plant has been installed and the station is working up to its fullest capacity, the combined power of the engines will reach the great figure of 120,000 horse power. The great coal bunker, which will be constructed immediately beneath the roof and extend the full length of the boiler room, will have a capacity of 25,000 tons, sufficient, if it were completely filled, to run the plant continuously for nearly a month. The coal will be brought to the docks at the river end of the building, where it will be raised by belt conveyors in an elevation of about 80 feet above the street, carried for the full length of the bunkers, and automatically dumped wherever it is required. From the bunkers it will be drawn off by gravity through chutes which terminate above the furnace doors. Here the coal will be delivered into the hoppers of the mechanical stokers, and after it has done its work in the furnaces, the ashes will be mechanically dumped at the rear end of the furnace into hoppers, through which they will flow into ash-cars, which run upon tracks to the river; there the ashes will be unloaded into scows. A remarkable feature of the building, by which indeed it may be easily recognized, will be the five great smoke-stacks, each 265 feet in height, and a novel feature in the construction of these stacks is that, instead of the chimneys extending completely down to ground level, they will be carried by massive steel platforms which will extend 40 feet above the floor of the power house. This is done to save a large amount of valuable space which has hitherto been monopolized by the square base of such chimneys. The building is of the usual steel and masonry type. The architectural features promise to be pleasing and appropriate to the size and character of the structure. The exterior wall consists of cut granite up to a certain level, above which it is built of terra-cotta and pressed brick, while the interior is lined with chocolate and cream-colored brick for the first two stories and above that with an attractive shade of buff brick.

Electric Motors for the Trains.—The Interborough Rapid Transit Company will operate two classes of train service. The first will consist of five-car local trains, composed of three motor cars and two trailers, making an average speed of approximately 16 miles per hour. The second will be eight-car express trains, comprising five motor cars and three trailers, making an average of 25 miles or more per hour; the same motors and gearing will be used for both classes of

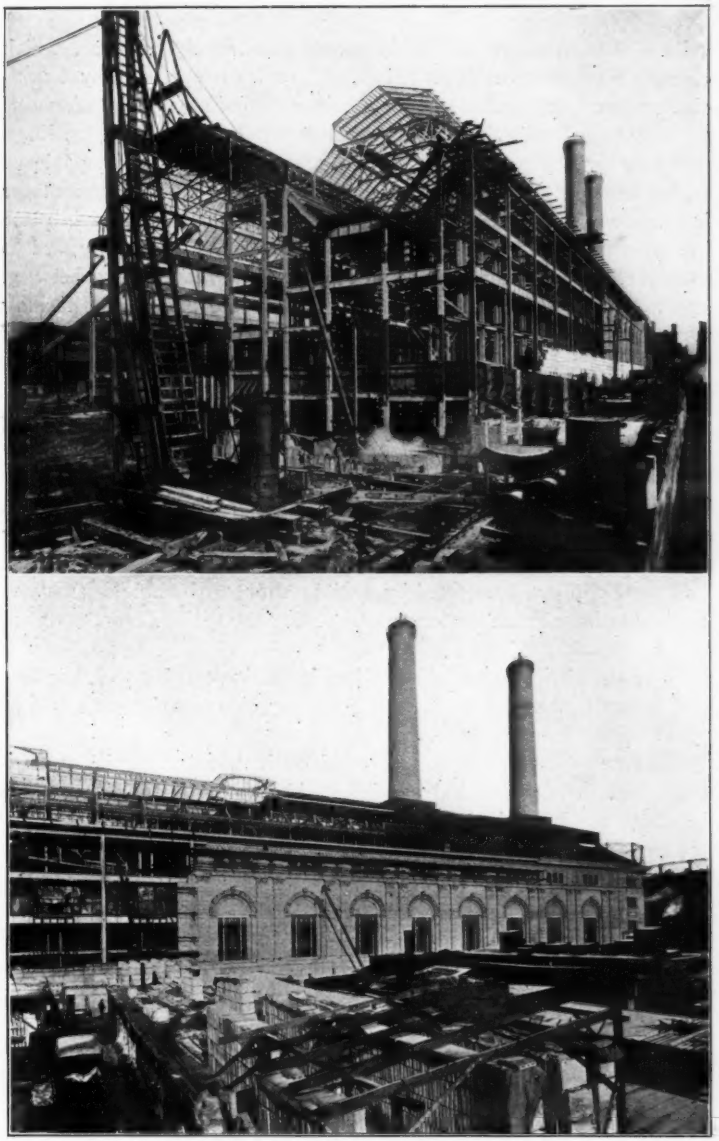
service. The motors, which are to be supplied by the Westinghouse Electric and Manufacturing Company, were designed especially for this purpose, and were made to fit the particular conditions and requirements involved; one of those requirements, and perhaps the most difficult, made necessary the designing of a motor of large capacity to fit into a limited space. As a result, the present motors are probably of smaller size for their output than any built heretofore.

The nominal capacity of the motors is 300 amperes at 570 volts, or 200 horse power. With this current and voltage, a tractive effort of 4,150 pounds is developed at the periphery of a 33-inch wheel, at a speed of 19 miles per hour. Although designed for an average voltage of 570, the motor will operate satisfactorily with voltages up to 625. It will carry loads up to 500 amperes without injurious sparking.

The motor has a field frame of cast steel, divided into halves on the line of the centers of armature and axle, and completely surrounding the axle. There are thus no separate axle bearing caps, and the number of pieces is consequently reduced to the least number possible for an easily accessible motor. The top half of the field can be readily lifted off and access gained to the interior for inspection and repairs.

The four pole pieces are made of laminated-steel punchings held between heavy end plates and secured by rivets. The field coils are made of copper, strap wound on edge. The insulation between turns consists of asbestos and mica, held in place by shellac and baked at a high temperature under heavy pressure, so that the coil and insulation make a solid mass. The completed coil is sealed in a curved metal case, from which it is insulated by moulded mica made like the V-rings of a commutator. This construction gives a coil which is absolutely fire-proof, moisture-proof, and practically indestructible.

The armature is 20 inches in diameter and weighs 1,930 pounds. It is of the slotted drum type, and is composed of sheet-steel punchings assembled on a cast-iron spider. The commutator is also carried on the same spider, and the shaft may thus be removed and replaced, should this ever become necessary, without disturbing the armature winding or its connection to the communator. The winding itself is of the two-circuit type, and is of ventilated construction. There are 53 slots and 159 coils, i. e., three coils per slot. Each coil consists of a single turn of copper strap. The coils are held in the slots by wedges of special unshrinkable material, which will withstand a high degree of heat without injury. This is a valuable feature, and gives a construction which is stronger and safer than the use of bands. It also greatly facilitates the removal and replacing of the armature



THE POWER HOUSE, DURING CONSTRUCTION.
Views taken early in the current year.

coils. The armature insulation consists essentially of mica, which extends between turns at all points. The mica is protected by a sufficient amount of fibrous material to insure against deterioration due to mechanical vibration. This fibrous material is treated with a moisture and oil-proof compound, forming an insulation capable of withstanding very high temperature without injury. The commutator is composed of 159 rolled and hard-drawn copper bars, held in place by two steel V-shaped rings, one of which serves as an oil guard to protect the mica thoroughly from oil or grease. A low voltage between the communator bars is secured, decreasing the liability of flashing from any cause. The bars are insulated from each other by sheets of mica of a hardness that insures their wearing at the same rate as copper.

The brush holders consist of two cast-brass arms, each carrying three carbon brushes 5/8 inch by 3 inches in section. The brushes slide over finished surfaces, and each is pressed on the commutator by a spring finger. The tension of these fingers is readily adjustable, and the brush-holder arm is arranged for radial adjustment to allow for wear of the commutator. Copper clips are bolted to the carbon, and these clips are connected by flexible shunts, of ample capacity, to the body of the brush holder, thus relieving the springs from carrying the current.

The completed motor will stand an insulation test between winding and motor frame of 4,500 volts alternating momentarily, or a test of 3,000 volts for one minute.

The armature bearings are contained in housings which are securely held between the halves of the field frame. These and the axle bearings are lubricated by oil fed to the journals by waste, in accordance with standard railway practice. The oil boxes are formed so that the waste will pack itself against the journals.

The gears are solid, of cast steel, with cut teeth. The pinions are forged steel with cut teeth. The gear-case is made of malleable iron planed to a tight joint, with a suitable opening at top having a hinged cover. It is supported at the ends by horns cast on the motor frame and so shaped that they support the gear case without side strain, the weight being carried in its own place. The whole motor can be dismantled with great ease and without the use of any special tools. Its total weight including gear, gear-case, etc., is about 6,600 pounds.

THE INTRODUCTION OF HIGH-SPEED STEEL INTO A FACTORY.

By A. D. Wilt, Jr.

Practical men often say that the engineering literature they want most is that which tells not only what to do, but how to do it. Mr. Wilt's contribution admirably fulfils this requirement in its definite description of the mode of preparing and handling high-speed-steel tools. A following paper will take up the management problems connected with their introduction and use.—The Editors.

THOUSANDS of dollars have been indiscreetly spent by some manufacturers in the introduction of high-speed steel into their plants. This is the case where too little systematic attention has been paid to its proper use. In factories which produce a variety of parts, the question as to whether or not it is better to use carbon-steel than high-speed-steel tools is one which in most cases can be decided only by a systematic study. And after its use is decided upon, many problems confront the alert manufacturer in introducing high-speed steel; in this review they will be discussed in the order in which they were met in factories with which I have had experience.

The first step taken in trying out some lathe tools, submitted by several different steel promotors, proved so successful that four or five different kinds of tools were made from as many different brands of steel, and these were promptly ruined by improper hardening. Realizing that the success or failure of the use of this steel lay in the hardening more than in any other feature, the first general question met was,

I.—Can high-speed steel be hardened successfully in tools of all shapes or sizes?

Some milling cutters of a small size were sent to the promotors of the steel to be hardened. Although the hardening was done properly and the tools worked successfully, it was not well settled that they paid, because the output, which increased somewhat, was limited by such factors as the speed of the machine and the condition of the part after having been operated on at increased speed. This brought up the following questions.

II.—What factors besides the successful hardening of the tools must be considered to obtain the highest efficiency from the use of high-speed steel?

III.—What is the best plan for introducing high-speed steel into a factory?

These questions, in general, confront every thinking manufacturer who realizes the great possibilities of this steel. Although much information can be obtained from the experience of others, many vital problems must be solved in each individual shop. The following discussion is the result of observations made of the use of high-speed steel and the machinery on which it is used in many prominent factories. No definite rules can be laid down, owing to the varying conditions in each factory; only prevailing practices will be proposed. The following pages will deal with the mechanical aspects of the problem—that is, the treatment of the steel and the handling and operation of the machine tools in which it is used. A succeeding article will take up the management problems and the record systems and forms for adapting piece-rate or premium systems to the changed conditions of working brought about by the new tools.

I.—Can High-Speed Steel Be Hardened Satisfactorily in Tools of any Shape or Size?—Tools made from high-speed steel are in extensive use, in sizes and shapes ranging from the smallest watch tools to the largest milling cutters. The consensus of opinion of many blacksmiths is that the forging and treatment of high-speed steel is much simpler and is accomplished with less risk than attends the same processes in the case of carbon steel.

As the composition of each brand of steel is different from that of other brands, it is no easy problem to determine the proper temperature to which a tool must be subjected. Every brand of steel has its distinct formula for heat treatment prescribed by the producer. In a number of different factories using the same brand of steel, as many different processes of heat treatment were pointed out by their respective blacksmiths as the best; they were possibly the best for their own particular use. How best to harden a tool for a specific use can be determined only by systematic and scientific experimenting.

Too little attention is paid in the average factory to the blacksmith shop. Its importance as an agent for greatly increasing production is carelessly overlooked. Some manufacturers have never reaped the full benefits from carbon steel because they have never provided means for recording results from constant experimenting, but have entrusted the keeping of most valuable data concerning the very essence of production—the tool—to the memory and eyes of their blacksmith. When he leaves them he carries with him information concerning their business which cannot be regained for years by his successors. It is now an established fact that there is one critical temperature for each composition of steel which will give the best results, and that a small devia-

tion above or below this particular temperature will greatly affect the life of the tool. The long practiced method of judging by the eye can no longer be relied upon to give correct temperatures, and is not advisable with the advent of high-speed steel, especially where large quantities are hardened. The reason is that the eye is affected by exposure to continued high and bright heats. In one factory in which I had experience no blacksmith is allowed to harden high-speed steel more than two hours continuously, and no other steel within two hours after that. Acccurate and reliable methods of determining temperatures must be employed, and records kept, if experimenting is to be profitably done; without these exact and definite data, available in tabular or graphic form, comparison is impossible.

Although high-speed steel is still in the experimental stage, it is produced with very little variation in its composition. At any rate, the changes in composition of any well-known brand are not so great that a record of the heats applied to tools made from it would be unreliable in deciding, without chemical analysis, the heat that should be applied to later made tools of this same brand. If the blacksmith is to profit by experimenting he must know how the tool stands up. As some high-speed steel tools last a long time, it would be impossible for him to remember the heat applied to such tools without the aid of some heat measurer. He might remember the type of furnace used and the cooling process, and possibly the temperature to which the tool was drawn, but this is doubtful where many tools are used.

There are several methods now in use for determining the heat of a furnace, or the heat received by a part—among them the pyrometer and the thermal gauge. It is a question whether such instruments read accurately after they have been used a number of times, but any change can readily be detected by the user. Where great accuracy is required it is best to equip the furnace with two methods, one to serve as a check upon the other. If the greatest accuracy is desired, the heat measuring should be accompanied by a chemical analysis of each bar of steel. In most cases this is impractical. After one brand of steel has been in use some time an expert blacksmith should have no trouble in hardening any tool properly with the heat-measuring appliances, and where four or five different brands of steel are used, or where the initial use is being made of one or more brands, these are of greatest help. The difficulty lies in persuading the blacksmith that such instruments produce results which would warrant his bothering with them, for they demand much attention compared with the old "hit-or-miss" method.

Some observations are herewith given of the most common methods employed on certain classes of tools.

A. Lathe, Planer, and Other Tools Requiring Only an Extremely Hard Cutting End.—In most factories this type of tools is hardened in an open forge—in a few cases, in small gas bench forges. The usual practice is to heat forged tools to a bright cherry, then grind down while hot on a dry surface to the required angle, and cool slowly in the open air. They are generally laid with the edge over a table until they become cold, and are then heated to nearly a fusing point and cooled in an air blast. In fact, all tools of this type are generally cooled in an air blast, preferably compressed, the tool being held at least five inches from the mouth of the blast. Sometimes they are reheated slightly to relieve the forging strain. It is not customary to draw the temper of this class of tools, but I have seen remarkable results from drawing them to a straw color. In a few cases, such as drills for certain uses which are hardened only on the end, they are cooled either in air to a good red heat and then in oil, or entirely in oil.

B. All Other Tools Requiring Hardness Throughout, not Including Punches and Dies.—It is the general practice of most blacksmiths to harden all other tools, such as milling cutters, in a gas furnace, and cool in oil. In some cases they are hardened in a forge, or in lead, and sometimes cooled in the air blast. It is my opinion that gas furnaces are the best in which to heat high-speed steel, from the fact that no flame impinges against the tool, that the heat can be more readily seen, and that the cutting edges of the tool do not come in contact with a hard surface. Chiefly for the last reason the cylindrical gas furnace is in most cases better than the gas oven.

All tools that can be suspended can best be hardened in a cylindrical furnace, this applying particularly to milling cutters, drills, reamers, etc. Drills, reamers, and long tools in general should be suspended in a vertical position. Most tools can be suspended by using heavy wire hooks, or by clamps. If the tools can not be readily suspended, a gas oven is best. The latter is used more extensively in heating large milling cutters, such as spirals and face mills. As has been pointed out, the greatest advantage of cylindrical over oven furnaces is that the work does not come in contact with any hard surface.

Another feature of the cylindrical type is that the heat can be applied slowly throughout by the method which follows, and the tool not plunged cold into a very high heat, as is the case when the gas oven or forge is employed without extra arrangements for preliminary heating. This is accomplished by first placing the tool on top of the

furnace until it comes to a dark cherry red heat, and then suspending it in the furnace. No time is lost by this method; for while one tool is directly exposed to the high heat another can be heating up slowly on top of the furnace. The reason that some blacksmiths prefer the oven to the cylindrical furnace is their lack of experience with the latter. It is true that the cylindrical furnace is harder on the eyes.

Whether or not tools of this class are better when the temper is drawn can be determined only by experiments. No specific drawing temperatures can be prescribed, but, in general, when this is necessary it is safe to draw the temper of certain classes of tools as follows:—drills to 475 degrees F.; taps to 525 degrees F.; milling cutters to 450 degrees F.; and threading dies to 525 degrees F. A method of discovering the proper temperatures is proposed elsewhere.

C. Punches and Dies.—Manufacturers do not seem to be so well assured of the benefits derived from using punches and dies made of high-speed steel. Although some wonderful results have been obtained from certain kinds of punches and dies, it is not so certain that they pay in all cases. In ordinary work, carbon steel will last a long time. This makes necessary a consideration of whether or not the part is liable to be changed in that time. Another consideration is the possibility of there being a flaw in the metal due to improper treatment. Owing to high cost and uncertainty of structure, it may not always be safe to use high-speed steel for this purpose. Some phenomenal results have been obtained from small round punches, such as those used for boiler plates, etc. In fact, high-speed steel is being used extensively in large dies, but nevertheless there is a question as to whether it pays in all cases. It is a good plan to harden high-speed steel dies in a gas oven, the temper being drawn to about 600 degrees F.

A useful accessory to hardening is an oil tank placed in a larger tank arranged for a supply of flowing water. A current of air is sent up through the bottom of the inner tank and through the oil. This not only aids in cooling the oil, but in keeping it at a uniform temperature throughout. Ordinarily the hot oil rises to the top of the can and retards cooling where only the end of the tool is to be dipped.

It is sometimes desirable, preparatory to hardening, to re-anneal tools having fine edges or delicate projections and recesses, in which sudden unequal expansions or contractions are liable. This relieves strains incurred in machining, and brings the steel to a normal condition, thus insuring uniformity in the hardening process.

The customary method of annealing is to cover with powdered

charcoal and heat in hermetically sealed boxes, for a period varying with the size, at a temperature near 1,800 degrees F. The pyrometer can be used with great advantage in ascertaining the proper annealing temperature.

II. What Factors Besides the Successful Hardening of the Tool Must Be Considered to Obtain Highest Efficiency from the Use of High-Speed Steel?—It is obvious that to increase production greatly a machine must be proportionately speeded up. A few experiments will demonstrate that a high-speed steel tool is capable of being run at a higher speed than many of the old types of machines will permit. In many cases heavier machinery is necessary, and in some cases lighter machinery. With few exceptions, provision must be made for increased speed.

Not only is it necessary to have improved machinery and stronger tools to get an increase of production with high-speed steel; we must secure also conjoined co-operation on the part of the workman. Without this co-operation the chief gain from using high-speed steel would be in its durability. To get the conjoined action of the workman, it is necessary that he be given some incentive to get the highest possible output from the machine; but even if he has this ambition, he can not obtain what he should if he guesses at the speed or feed to be employed on any piece of work. So we have, in general, three factors besides the steel and the tool itself entering into the increase of production, namely:—

1. Improved processes and machinery.
2. Ambitious workmen.
3. A means of ascertaining from daily experience the most economical way in which to remove stock.

1.—A revolution in machine design has begun within the last three years among wide-awake manufacturers, who have realized the possibilities of high-speed steel. The outcome has been the production of some most creditable machinery. Some marked changes are observable in the following types of machinery:—

A.—Lathes, Planers, Boring, Slotting, Threading, Cut-off and Other Machines of This Type.—As a rule heavier machines are employed to do lighter work with high-speed steel than formerly with carbon. A great many companies have produced a lathe geared altogether differently from any previous type. In general, heavier machines with increased speed are used on lighter work. The tools are not always heavier. It seemed a problem as to whether tool holders would be profitable with high-speed steel, and also whether the cutting angles of

the tools should be changed. Some manufacturers are grinding their tools at angles different from those used on carbon-steel tools. A saving in high-speed steel can be effected by using it only on the cutting end of this class of tools. It can be welded readily to carbon steel.

B. Drills.—It is a question among a few manufacturers as to whether high-speed drills in sizes under 1/2 inch, but it has been my experience that they can be used with great advantage in size as small as 3/16 inch. This, however, does not apply to all brands of high-speed steels. High-speed drills in sizes over 1/2 inch are certainly better than carbon. Instead of heavier presses, which one would think necessary for increased speed and feed, one of much lighter type has been constructed which does wonderful work. It is built with any number of spindles for heavy or light work as might be required. As the press has ball-bearings throughout, the friction is greatly decreased, allowing greater speed without heating. Where the main spindle slides up and down through the cone pulley it has two splines with rollers in place of a key. I saw, with this press, a 7/8-inch hole drilled through a block of cast iron 1 3/8 inches thick in 15 seconds. The machine was run by a 1-inch belt. This press has not yet been constructed for extremely large drills, but it should be practical in almost any size.

C. Automatic Screw Machines.—The tendency seems to be to use heavier machinery to do a lighter class of work. Radical changes are not as noticeable in this class of machinery, however, as in most others. Heavier tools are used where high speed is possible. Most of the old types are capable of being speeded up a great deal.

D. Milling Machines.—Some manufacturers of this class have had to entirely reconstruct their machines. In most cases provisions have been made for an increase of speed, accompanied by greater strength to overcome vibration as well as wear. In some cases the ordinary type is capable of taking care of as great a speed as the part operated on will permit. High-speed-steel milling tools seem to be more efficient with a greater number of cutting teeth than were formerly used in carbon-steel tools.

Besides improved machinery there are several factors which must enter conspicuously into the use of high-speed steel. Important among them are automatic magazine feeds. Where formerly the tool in many cases limited the output, it is now limited by the endurance of the workman. Automatic magazine feeds are in use on such machinery as turret lathes, drill presses, punch presses, screw machines, and even milling machines. As a rule they must be constructed to suit local conditions.

It is to the interest of every manufacturer using high-speed steel to devote attention to their use, and if necessary to consult experts in this line.

Another most important factor is compressed air. Its chief advantage is in blowing away chips which, if not removed, are formed with such rapidity as to injure the tool. A very interesting form of the automatic screw machine has been constructed which operates almost entirely by compressed air. It is used with great advantage on numerous fixtures, such as chucks and drill jigs. Its value in jigs lies in its ability to instantaneously tighten any number of clamps. In fact, its chief advantages are its simplicity and its quick action. Its disadvantage is its cost. Conjoined operation of compressed air, automatic magazine feeds, and high-speed steel is a royal road to cheapened production.

2. The problem of interesting workmen in increasing their output is a subject too broad for this article.—It belongs, indeed, to shop management generally, and exists wherever tools are used, whether of old types or new, though of course it becomes more acute as the possibilities of extremely rapid production are increased. In general, to attain the maximum of interest to the workman there must be, besides fast tools, a good piece-rate system, such as the premium plan or Taylor's differential system, good-will between employer and employee, and stability of employment for the workman, accompanied by a desire in him to better his condition.

3. The most economical way to remove stock can be ascertained only from daily experience. There seems to be some doubt as to whether high-speed steel pays on brass, and a few manufacturers even hesitate to use it on cast iron. There is also some doubt as to whether it pays on finishing cuts, but the consensus of opinion is that it does. At any rate some manufacturers have wasted much money by using high-speed steel too extensively. As one expert on this subject said, they have gone "high-speed crazy." Other manufacturers have been too conservative in their use of this steel, and have therefore lost money by not taking advantage of the opportunities of increased production. There is only one way to determine how far to use it, and in the next issue of this Magazine a plan for doing this will be proposed and developed, with reproduction of the requisite forms and record systems.

THE PAST AND PRESENT OF THE MINES OF MEXICO.

By G. C. Cunningham.

The author of this article is resident in Mexico, and in close touch with practical mining work in that country. The text has been submitted to a well-known mining engineer whose practice makes him intimately familiar with conditions in Mexico, and it has his full endorsement. It is presented on the authority of these two excellent sponsors.—THE EDITORS.

MEXICO has for so many years been a land of romance that, to this day, one is in certain circles reluctant to speak of things Mexican, for fear of not being believed. For instance, some months ago I was crossing on a Pennsylvania ferry-boat with a group of typical New York business men, who were discussing with much incredulity newly read newspaper reports about Pedro Alvarado, the Mexican millionaire—he who was in one day transformed from a poor laborer into one of the richest men south of the Rio Grande. It happened that I knew Alvarado—knew that the reports about him were perfectly true; moreover, having lived for half a life-time in the Republic of Mexico, I was interested to hear what these men had to say on the subject. They were all prominent, well-known New Yorkers; one was a big importer; two, bankers of renown; another was a lawyer of international repute, and the last a street-railway man. None of them, it appeared, had ever been to Mexico, but they nevertheless spoke their opinion of the country, its resources and its future, etc., and the consensus of their united opinion was:

"It is all rot; you can hear pretty nearly any fabulous tale about these Mexican mines, and it is dollars to doughnuts that none of them ever paid a dividend."

The oldest man of the group (who, it appeared, had large copper interests in the Lake Superior regions) nodded his head. "You are right, gentlemen," was his verdict. "I'd like to see a list of Mexican mines that pay, or ever did pay, a dividend."

Having thus damned the mines of Mexico, these men proceeded to discuss, first, the absolute surety of revolutions in Mexico upon the death or retirement of Diaz; second, the trouble that was bound to occur when Mexico changed from a silver to a gold currency basis.

I listened breathlessly, and was genuinely grieved when the ferry-boat bumped into her slip; there is nothing more amusing than to hear men who really know something make statements such as these gentlemen advanced with such assurance.

It is for the benefit of men such as these, as well as for the enlightening of other Americans who have no correct idea of the sort of country they have to the south of them, that this article is written. The statistics and figures that it will set forth are absolutely correct, having been checked with Government and private reports, and with the City of Mexico *Boletin,* for which reason the figures given can be absolutely relied upon.

No one can tell when mining really started in Mexico. When the Spaniards came here in the year 1520 or thereabouts they found a great deal of gold, silver, copper, besides other minor metals and precious stones. Many mines were then being worked in a fashion by the natives, and many of these mines were ingeniously hidden by them from the Spaniards—so ingeniously that they have not all been located, even to this day. Numbers of Indians were tortured, in the effort to make them disclose the whereabouts of such mines. Some of the Indians weakened and told, but others did not.

When the conquest of Mexico was finally accomplished, the conquerors inaugurated the Spanish mining era in Mexico—which has since been superseded by the American. Driven by Spanish task-masters, the natives of Mexico were forced to locate mines, and then labor in them. In the mining system of those days the question of "expense" was entirely eliminated; the slaves had to work for nothing; if they would not work, the Spaniards flogged them to death. Under this somewhat strenuous method of dealing, some of the greatest mining camps in the world were located—opened up, so to speak—and gophered to their fullest extent. During the period lasting from 1550 to 1700 most of the great Mexican mining camps were located; many others, however, were so far from the sort of communication provided in those railroad-less days that they were little explored. But at this time the camps of Real del Monte, Taxco, Guanajuato, Zacatecas, Catorce, San Dimas and others were uncovered.

During this period some burro drivers accidentally discovered a mine in Guanajuato. This old mining camp—now pretty well worked out—produced within the next two or three hundred years over $1,000,000,000 in silver and gold, of which the Conde de Valenciana (originally a poor prospector) acquired $100,000,000. The records of "La Valenciana" still exist in Guanajuato and the City of Mexico.

In Taxco, down in the more remote State of Guerrero, a wandering, "good-for-nothing" Frenchman, by the name of Borda, found some mines. Rather, they were prospects; he made them into mines. They produced in round numbers something like $40,000,000, and their owner became known as "Señor Don José de la Borda," a man of standing and renown. He it was who built the beautiful gardens in the town of Cuernavaca, afterwards frequented by the Emperor Maximilian and his Empress—nowadays by the American tourist. Borda, with the usual lavishness of the miner the world over, built churches, endowed this institute and the other, and generally threw away his money until finally he died, in abject poverty, with not a cent remaining to tell the tale of the original forty millions! Perhaps, however, he was one of those millionaires of whom we read, whose pervading wish is to die poor.

Another poor man who eventually became a multi-millionaire through Mexican mines was one Pedro Romero de Terreros. Originally he was an insignificant store keeper, but he "struck it rich" to the extent of many millions of dollars. One is glad to record that *he* did not waste his millions in the building of churches, or riotous living; on the contrary, so wisely did he handle himself and his riches that he was created Count of Regla, became the friend of the King of Spain, and was held in honor throughout both Old and New Spain.

During this period Zacatecas gave to the world a total production of $900,000,000 in gold and silver; a little later Real del Monte (the famous English camp about which Charles Dickens wrote in his "Household Words," etc.) contributed the mere bagatelle of $600,000,000. All of these great mining camps were more or less centrally located; that is, in the central-southern part of Mexico. Those of Chihuahua, Sonora and Sinaloa, being very remote, were not explored by the Spaniards to any great extent; in fact, even now they are not well exploited.

In Durango, however, there were some great mines, and the most promising ones were found and opened up, nearly one hundred and fifty years ago, by a Spaniard named Zambrano. He it was who found the mine of "Candelaria," and existing records show that he took out of it over $100,000,000 in gold and silver values.

Most of the Spaniards merely gophered a mine—that is, dug out the richest ore where found, regardless as to whether any pillars were left for supports or not; "after them the deluge" they probably thought. But Zambrano evidently knew something about mining; he stoped and worked systematically, and went on down all the time. He

worked the "Candelaria" to a depth of 2,000 feet, and the rock and ore thus dug out went to the surface on the backs of peons. Water, when encountered, was hoisted out in the same manner.

Zambrano, his "pile made," did not suffer his light to be hidden under a bushel. He spent his millions right freely, among other things taking tours abroad in great splendor, building noble mansions, and otherwise using his money to advantage. When he died (which occurred after the finish of the American-Mexican war) he left among other assets the neat little sum of £12,000,000 on deposit in the Bank of England. So exit Zambrano, last of the Spanish miners—peace to their ashes! This brings us down to the present century; and, in view of the above statistics of wealth taken out of Mexican mines, it may sound unreal to say that mining in Mexico is only in its infancy. Yet anyone who really knows the country—its past mining records, and what it can do under up-to-date mining methods—will tell you this same thing. For this reason:—

Most of the mining described above was done in the most primitive manner, under ignorant direction, and by ignorant labor. At that time there were no methods of treatment beyond the patio process—a crude and lumbering one, at best. Therefore it paid only to gopher out such ores as carried undoubted high values, and either did not have to be treated at all, or in that event could be patiod. For this reason ores that carried a value of, say, 5 kilos (150 ounces), would be taken out, and anything less would be left in the mine, or thrown away on the dump, being worthless from their point of view. And as they dug out this rich ore as they found it, doing no timbering and leaving no pillars of ore to act as supports, naturally the mine would sooner or later cave in on them, and they would have to abandon it, even though it was really only scratched on the surface, and enormous values lay underneath their gopherings. Therefore, when you hear of a rich mine, "first worked, and abandoned by the Spaniards," do not condemn it as obviously a fairy tale, and say "If it was so good, *why* did the Spaniards abandon it?" For there are many such mines in Mexico, in South America, and wherever else the Spanish miner left his trail.

Under the present-day method of mining and ore-treating, ore carrying only 1 kilo in value is often bonanza, according to its distance from railways, local smelter rates, etc. So that the abandoned ore on the dumps of these old Spanish mines, and the refuse that they left behind them, can be handled to immense value when one uses the modern American methods.

Coming down to present days and figures—which always speak louder than words—some of the Mexican mines are paying regular monthly dividends as stated below, the dividends quoted being for the month of January, 1904.

Companies.	*Per share.*	*Total paid.*
San Rafael	$48	$57,600.00
Peñoles	40	100,000.00
Norias de Bajan	30	30,000.00
San Rafael (2nd)	24	28,800.00
Soledad	20	19,200.00
Dos Estrellas	10	30,000.00
Natividad, Oaxaca	10	24,000.00
Real del Monte	10	25,540.00
Sorpresa	10	9,600.00
La Blanca	5	62,500.00
Sta. Maria de la Paz	5	48,000.00
Victoria, San Luis Potosí	5	12,500.00
San Carlos, Zacatecas	5	12,500.00
Esmeralda, San Luis Potosí	5	12,000.00
La Union, Reduction Works	4	12,000.00
Santa Gertrudis, Guadalupe	3	180,000.00
B. de Medina, Reduction Works	3	6,000.00
Turquesa, pfd. stock	3	750.00
Total of dividends paid		$670,990.00

This list is taken from the regular monthly notice, which is issued every month in the City of Mexico. It is taken at random, and is given merely to show what just a few of the Mexican mines are doing, for the list in question includes merely a few of the centrally located mines, and does not mention the great number of mines that are located in the most populous mining districts For instance, the great mines of Chihuahua and Sonora are not spoken of. I believe that even the incredulous gentleman who had copper stocks, and who wanted to *see* a "list of Mexican dividend-paying mines," would think the above random showing no poor one.

Included in the above list, however, are the famous mines of "Natividad," Oaxaca; "Peñoles," Mapimi, and "Dos Estrellas," of El Oro.

The "Natividad," English-owned, yields in a six-days run of its mills 15,674 ounces of silver and 489 ounces of gold. The mine has for years paid a regular monthly dividend of $6 per share, and the stock consists of 2,400 shares, which are quoted now at $1,000 each, par being $30. Anyone can readily estimate what percentage is made on this investment, and no one will wonder that "Natividad" stock cannot be bought.

The "Peñoles" of Mapimi is German-owned; and while information regarding this mine is not easily secured by the public, still it is known that millions of dollars were spent on it before any values were taken out. Then the company went to work mining good paying ore; they have been doing this ever since, with the result that their monthly dividends amount to $100,000, and their shares are now quoted at $4,000 each, with none offered on the market. This mine has enormous values blocked out for future work, and their manager gets in salary about the same sum that President Diaz is paid for directing the affairs of the Republic.

These are only samples; with time, and sufficient room, one could give descriptions of a great number of Mexican mines that are today busily hoisting out ton after ton of pay-ore, and paying regular dividends. But these data would fill a book.

There is the "Dos Estrellas" mine, for example—considered by experts as one of the best gold mines on the Western Continent. And one would also like to tell at length of a Danish sailor named Sahlberg, who "laid off" on one of his trips to a Mexican port, and prospected a little in the El Oro camp. There he denounced a prospect which later became the great "Esperanza" mine. It made its fortunate owner a multi-millionaire.

None of these mines is in the north-western region of Mexico, wherein most experts agree that the coming mining territory of Mexico will exist. This of course includes the States of Chihuahua and Durango, while Sonora is a magnificent district. In fact, more American mining capital is invested in Sonora than in any other State of Mexico, while Chihuahua follows close behind.

Probably the most favorable feature about mining in these northwestern States is the amount of gold that is being discovered, as prospecting and development approaches the Sierra Madres. In the State of Chihuahua there are now producing gold mines which have only just been opened up, but which are making splendid showings already. The famous "Lluvia de Oro" gold mine, not a very great distance from Parral, Chihuahua, is already spoken of as "one of the world's great gold mines"; while the "Adela," located within a three hour's ride of Parral, is a very fine mine.

Because of her silver standard, Mexico is generally spoken of as a silver-producing country. Not altogether without reason, for she has produced, up to date, nearly *four billions* worth of silver. Even so, however, her gold output has lately increased most notably, having made a twelve-fold increase within the last twenty-five years.

For 1890-1891 her gold output was $920,702; for 1901-1902 it was $9,928,386.28, while for the fiscal year of 1902-1903 it had increased to $14,805,975.27.

Mexico's silver output for 1902-1903, by the way, was $82,320,735.32, while copper was $18,353,943. As a copper producer, Mexico now ranks second, being exceeded by only the United States.

Proven, however, that Mexico has dividend-paying mines, there are still people like the gentleman of the ferry-boat; while willing to invest in Lake Superior copper—Schwab "Ship Trust"—and other such investments, they nevertheless fear to put money into Mexico, for fear, first, of revolutions; and, second, of the troubles that will ensue when the money basis is changed from silver to gold.

So far as revolutions in Mexico are concerned, it is not necessary to say anything more than to point out the fact that the United States has over $500,000,000 invested in Mexico, half of which has been invested here within the last five years. Americans control all of the great railways, particularly those from the border; they control the smelter trust, the greatest mines, the manufacturing enterprises, the electric-power plants, and even the street railways. Americans swarm from one end of the Republic to the other; there is hardly a mining camp, a station eating-house, a desert-place, even, where one or more Americans will not be found. There is hardly a Mexican town where one cannot hear the familiar vernacular of the United States.

These things being so, does the most ignorant politician believe for a moment that in the remote event of trouble in Mexico upon the death or retirement of Diaz, any trouble or molestation would be visited upon the Americans in Mexico? Not for a moment; what the Mexicans thoroughly believe in their hearts (particularly since this Panama matter occurred) is that the United States is simply *aching* for a chance to get her claws on Mexico! The great officials believe it; the lower classes, and even the peon workmen have this idea. From personal experience and knowledge, I believe that *no slightest chance will ever be given the United States to retaliate, in any manner whatever, for offences to United States citizens, or their property, in the Republic of Mexico.*

As for monetary reform:—there is no doubt that within the next few years Mexico will change from silver to gold, or else arrange a certain fixed price of silver. But one fails to see wherein anyone will suffer loss thereby; it has not been the experience of the many countries that have changed their monetary systems.

THE INDUSTRIAL VALUE OF MANUAL TRAINING.

By Frank T. Carlton.

The series of articles recently published in this Magazine dealing with the apprenticeship question (December, 1903, to June, 1904) have considered almost altogether the maintenance of the supply of future industrial *materiel* by institutions existing within the shop. Mr. Carlton goes back to the training of the boy before he has reached the age of apprenticeship, and discusses what can be done, under modern conditions, to make the school supply that simple but very important skill in handicraft which in more primitive society the boy gained by the "chores" at home.—THE EDITORS.

AS the years pass by, industrial and social institutions suffer constant change; the relative importance and value of this function of one increases, while that function of another decreases. A readjustment is necessary in order to meet the new situation satisfactorily. Progress is change—growth on the one hand, decay on the other. New functions and duties devolve upon some institutions; other functions are gradually transferred from one to another. New inventions, methods of rapid transportation, increased trade, the growth of cities, change radically the relations existing between the home, the factory and the school. With the rise of the modern factory system, the decay of the old forms of apprenticeship, and the introduction of an extreme and minute division of labor, conditions in the industrial world were revolutionized. The home and the factory are now sharply differentiated; the factory assumes many of the functions formerly belonging to the home. The latter, particularly when situated in the city, offers very little opportunity for observation of, or participation in, constructive work of any kind. The home chores are few; there is no wood to split, no garden to hoe, no cow to milk, no blacksmithing is done, no shoes are made, no cloth is spun, and no wagon or sled is built; all this work is performed elsewhere. In fact, the city home provides no regular and systematic work of importance for the youth.

The work in our shops has become so specialized that a boy from the time of his entrance is forced into a rigid and monotonous routine, usually tending automatic or semi-automatic machines. He is able to observe or learn little beyond the few simple operations required of him. As a consequence he soon gets into a rut, and is unable to change readily to another kind of work, except that involving little

skill. It is this unreasoning, uncomprehending boy who becomes the inefficient and unreliable workman. Apprentices are given better opportunities, it is true; but a few only of the larger engineering establishments receive apprentices, and in those their number is necessarily limited.

The value of the home and the shop as factors in the training of future workmen, foremen, and engineers has greatly decreased as a result of the changes just mentioned. As this function of these two important institutions atrophies, the school is obliged to take upon itself new obligations; its sphere of action and influence is enlarged to meet the new situation. The technical school, the manual-training high school, and ward-school manual training, have been grafted on to our educational system to meet the demand for boys who possess trained hands and eyes—boys who are able to plan and to execute—boys who are industrious and not afraid of overalls and jumpers—boys who have to a high degree the power of applying knowledge to industrial operations. The value of a good home in the building of character is not minimized or called into question. But the changed environment in and about the home, its complete isolation from productive industry, cooking excepted, has caused it to lose its leading position as a factor in industrial training.

The future of manufacture depends largely upon the new human material which is supplied to the shop and factory. Brains, the ability to do, not stores of unassimilated and unapplicable knowledge, is the great need and demand of today in the machine shop and the foundry as well as in the counting house and the Congressional chamber. The school must be looked to in the future to fill this standing order for trained, resourceful men.

A line of demarkation must be carefully drawn between the trade and the manual-training school. Both are important; both have a legitimate place; but the aims and ends of each are different. The trade school turns its energies toward fitting the student for some particular trade. The manual-training school, on the other hand, attempts to give a more general training. The latter does not aim to make carpenters, blacksmiths or mechanical draftsmen; but it does strive to give the student a first-hand knowledge of industrial operations and processes. The trade school ought to complete the school training of a skilled worker who has taken the manual-training work which should be given in the public schools. The trade school is to the skilled artisan what the technical school is to the engineer. The manual-training school is designed to be a preparation for either.

Manual training aids particularly the two classes of workers in the industrial field: first, the young men who are fitted for, and able to take, advanced technical work; second, those who must go directly from the grammar or the high school into the shop, or in some cases into the trade school.

The latter class must not be overlooked or neglected as unimportant. It is unfortunate that our school curricula are drawn up primarily to benefit the small percentage who go to college or technical school; secondary consideration only is granted the larger number who go directly into their life work. The future progress and prosperity of the country is as dependent upon a trained rank and file in the shops as upon the superior character and training of our superintendents and engineers. The value of higher technical training is dependent upon the efficiency of the preparatory work in a two-fold manner. The quality of the work done by a student in the technical school is materially affected by the kind of training which he has previously received in the preparatory schools; and the best engineer needs competent workmen in order to carry his projects to a successful issue. Our technical schools might be the best in the world; their graduates might be the very skilful engineers, chemists, superintendents and designers; and yet if the workmen who are to be directed by these men are inefficient and unskilful the results of their combined efforts would not be encouraging. Our industrial system would be top-heavy.

The boy who goes into the shop in his early youth must be taught neatness and accuracy; and he should understand the elementary principles of wood and metal working, mechanical drawing, algebra, geometry, and have a fair command of the English language. If the boy can be kept in school until the end of his sixteenth year, this amount of training can be given him. The last two years of this course, which are the first and second years of the average manual-training high-school course, are extremely important. I believe that the value of this work is often underestimated. Technical education was introduced before manual training, and when the latter was first recognized it found a place only in the high school. Gradually, grade by grade, it has crept down toward the kindergarten until, in a few American cities, manual training is found in each of the twelve grades. The universal introduction of such work into the public-school system should be demanded by clear-sighted employers and labor leaders; but, in order that the young men may reap the benefits, the school age must also be raised. If the employer and employee will unite on

this proposition, it will mean much in the future. The interests of both are certainly harmonious in this instance. A well-trained class of workers means the maintainance of industrial supremacy, and the greater likelihood of peaceful relations between employer and employee. Ignorant, inefficient, and "sweated" laborers are a menace to industrial growth and development.

The large number of students, living in all sections of the United States, who are taking work in correspondence schools, in public, private or Y. M. C. A. night schools, testifies to the great demand for elementary technical education and manual training. Many of these persons left school at an early age because they were unable to receive instruction of this character. School teachers are as a rule very conservative. They are too often far removed from the practical affairs of life, and few of them have received such an education as will make them appreciate the need of industrial and manual training. This movement toward greater emphasis on industrial education must be accelerated by those actively engaged in industrial pursuits. The latter should be keenly appreciative of the need of well-prepared timber for the future industrial edifice.

Turning our attention to the other boy, the future technical-school student, the question immediately arises: What preparation does he require? It may be safely assumed, with little fear of controversy, that intellectual training alone does not properly fit any boy, especially one who is to be engaged in engineering pursuits, for the active duties of life. It is extremely desirable, if not absolutely necessary, that the youth who is to be the future engineer, superintendent, foreman, or manager should receive a careful training of eye and hand, and that he should be brought into direct and personal contact with materials and machinery before he enters the technical school at the age of eighteen or nineteen. This experience can be given him in the public schools. The preliminary work for the engineer need not be differentiated from that given the skilled workmen. Both classes should receive the same instruction.

If this instruction were given in all or a majority of city and village schools, the manual-training high school would relieve the technical school of the necessity of teaching joinery, wood turning, elementary pattern making, forging, elementary machine-shop work, and much of the simpler work in mechanical drawing. In drawing, for example, the graduate of the manual-training high school should understand orthographic and isometric projection, perspective, tracing, and blue printing. He should be able to execute neat, accurate, and

well lettered working drawings of existing machines; but he should not be expected to design such machines.

Manual and mental training must ever proceed hand in hand; the one is not complete without the other. Exactly as the arithmetic, the algebra, and the geometry taught in the high school are preparatory to the work in higher mathematics of the technical school, should the shop work and drawing be equally preparatory to laboratory work and machine design. The present duplication of equipment and consequent waste of energy can be avoided. The technical school has its own definite and urgent problems to solve; it ought not be asked to maintain this preparatory work which should be given to all who enter industrial pursuits, workmen as well as engineers.

The American workman is intelligent and resourceful; as a consequence he is a very efficient man. The United States, thanks to its material resources and the sturdy character of its inhabitants, has forced itself into the front ranks of industrial nations. Shall it continue in this desirable position? It has cherished one institution which, if properly utilized, will enable an affirmative answer to be returned to this question. This is the American public-school system. By means of its effort the present high grade of intelligence and efficiency can be maintained; but its future ideal must be to find the proper work for each of its students. The school must say emphatically that a first-class machinist, a good fireman, or an excellent carpenter, is to be preferred to a second-rate lawyer, physician, minister, or teacher. The necessity for primary, grammar, and secondary manual training is great. The schools have too long given a major portion of their time and energy to a training which was particularly beneficial to the professional man. The foundation of industrial education should be laid strong and well; good work in ward and high schools is essential to future progress in the arts and sciences.

A careful study ought to be made as to the extent and character of the industrial work which might profitably be introduced into the public-school system; manual training, particularly in the ward schools, is still in an unsettled and experimental stage. The methods employed and the extent and character of the work given are by no means uniform. The employer and the employee as well as the educator must consider this question; out of the conflict of opinion good will come. Let it ever be remembered that competent men are needed in all grades of industrial work, and that the public school should render valuable service in supplying this demand.

THE MINES AND MINERAL INDUSTRIES OF ITALY.

By Enrico Bignami.

Signor Bignami's descriptive account of the lead and zinc mines of Sardinia will be followed later by a similar review of the sulphur production of Sicily, thus covering the most important mineral industries of Italy.—THE EDITORS.

SINCE the time of its political unification, Italy has been divided into nine mining districts, of which the most important is that of Iglesias, including all of Sardinia. Its production represents half of that of the entire kingdom, exclusive of the production of sulphur, which is obtained almost entirely from Sicily. In 1902, for instance, while the metallic products of all the mines of Italy had the value of about 50,00,000 lire, those of Sardinia contributed about 25,000,000 lire to that total.

Of the two provinces into which Sardinia is divided, Sassari and Cagliari, the latter is the richest in metallic minerals. From the most ancient times this richness has attracted the attention of scientists and promoters. The first works go back to the Phoenicians. In the period which followed, the Carthaginians and the Romans* applied themselves also to the mines; but after the fall of the Western Empire the art of mining fell into oblivion throughout the island until the eleventh century. At that time the works were taken up again by the Pisans and the Genoans until the fourteenth century, and then again by the Arragonese, only to be abandoned again upon the discovery of America. After that time it may be said that the mines had been left in almost complete oblivion, and that it was only upon the annexation of Sardinia to the kingdom of Piedmont that they began to revive.

In the province of Cagliari lead and zinc mines have the preponderance; the same may be said of Sassari, but as compared with Cagliari, its mines are in the ratio of 1 to 14. For both provinces however, the fact is noteworthy that, while in other well-known

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mining centers the production is restricted to a single kind of metallic ores, in Sardinia almost all metallic ores occur in quantities more or less large; some, like lead, silver, and zinc, in very remunerative veins; others, like iron, manganese, antimony, copper, nickel, and cobalt, in smaller quantities, but still commercially workable; still others, finally, among the immense variety of mineral species associated regularly or perhaps accidentally with the predominant minerals or rocks, are of no industrial value, but nevertheless interest scientists who find in them an endless field of mineralogical, crystallographical, spectroscopic, and geological researches.

Mineral fuels are present also; the beds of lignite and of anthracite are of considerable importance, especially as the principal ones are situated in exactly the region where they are needed for industrial purposes.

Although, as said, the metallic wealth occurs throughout the whole surface of the island, and new fields are opening everywhere to the discovery of various kinds of minerals, it is chiefly in three regions of great importance that the mining has risen to the proportions of an industry of the first order—Iglesiente, Nurra, and Sarrabus. In the first two, ores of lead, more or less argentiferous, hold the field; in the last, those of silver and antimony and the so-called mixed ores, that is to say, those composed of sulphides of lead, zinc, and copper.

The decline in price of silver and the difficulties of treatment of the mixed ores at the present time have greatly reduced the activity of development of the mines of Sarrabus, which once had a period of exceptional prosperity; while the lead and zinc mines of Iglesiente, and the very important and almost isolated silver mines of Nurra, are in a condition of considerable prosperity. In Iglesiente the metalliferous region may be divided into two zones, characterized, in a way, by the two mines which we are about to describe in detail, in the hope of giving a definite idea of the progress made by Italy in the art of mining—the mines of Montevecchio at the north of Iglesiente, and that of Monteponi, farther south.

Montevecchio.—The mines of Montevecchio are in the townships of Guspini and Arbus (district of Iglesias), but a few miles from the seacoast of the southwestern part of the island of Sardinia, and extend for about eight kilometres in an east and west direction, taking in a series of hills which frequently attain a height of 600 metres or more above the level of the sea. They may be reached by a good wagon road, and from the station of Sangavino Monreale by the railroad which belongs to the mines. At the two terminals

of the line are large stations with buildings for lodging employees, very large roofed storehouses, and immense storage yards.

While very evident traces of ancient workings dating back to Roman times and even earlier are observed in the numerous mines of Sardinia, in the mine of Montevecchio ancient excavations of any importance are entirely lacking. Nevertheless it can not be affirmed that the great wealth of its veins entirely escaped the notice of the ancient miners. In fact, in old excavations, in the concessions of Seiria and Piccalinna, have been found amphora, funeral urns, earthenware lamps of the Roman period, and copper cups, as well as a mining pump of great archeological interest, together with other objects of the use of which we are not yet certain; and in the museum at Cagliari is preserved an ancient lump of lead found at Carcinadas, bearing the inscribed words: "Imperator Caesar Hadrianus Augustus."

When gunpowder was discovered and came into use in mines, even the harder veins began to be worked, and it may be supposed that under Eléonore d'Alborea those of Montevecchio were worked a little, especially as she had founded a mint at Oristano. The first concession of which modern history makes mention is that granted to a man by the name of Squirro; after it, others are met with; but that upon which the real industry is founded was granted in 1845 by the king Charles Albert to Monsieur Antonio Senna of Sassari, in perpetuity. For the exploitation of this concession and two others, the Société de Montevecchio was founded. Later it acquired two new concessions, those of Seiria and Piccalinna (page 937) and thus came to possess five large adjoining concessions, extending over 2,000 hectares of land altogether, and containing seven kilometres of veins, which really produce about one-third of the lead ore derived from Sardinia.

In the northern part of Iglesiente, directly north of the massive granite of Arbus, where a schist formation is found covered with great tertiary deposits near Arcuentu, the out-croppings of the vein of Montevecchio rise majestically. The vein runs in a northeast and southwest direction, at a nearly constant dip of 60 or 70 degrees. The thickness of the vein is very remarkable, so that it may be considered one of the most important of Europe; at some points it reaches 50 metres. In reality, however, the vein of Montevecchio is not a single one; it is composed of a system of three distinct, nearly parallel veins. The lengths of the three veins are not equal; all three begin at the east, but the chief one does not reach beyond the limits of the

first concession, while the other two extend much farther to the west, and both cross the western concessions.

From the two larger veins in the first (eastern) concession, two branches separate, turning a little to the south, but they are not of very great importance. On the other hand, at the south of this group of veins, that is to say in the direction of the massive granite of Arbus, there are three more veins running in a direction perpendicular to the first. Dikes of eurite, well worth the trouble of excavating, run parallel to these latter. This collection of veins forms therefore a great deposit divided in two directions perpendicular to each other; it probably forms a single system, due essentially to a dynamic phenomenon. The veins of Montevecchio have a matrix of quartz; in the principal vein the quartz is compact, in the secondary vein it is friable at various points, and in the third vein it is rich in pyrites. In the outcroppings of the second vein, however, considerable quantities of barite and siderite occur with the quartz.

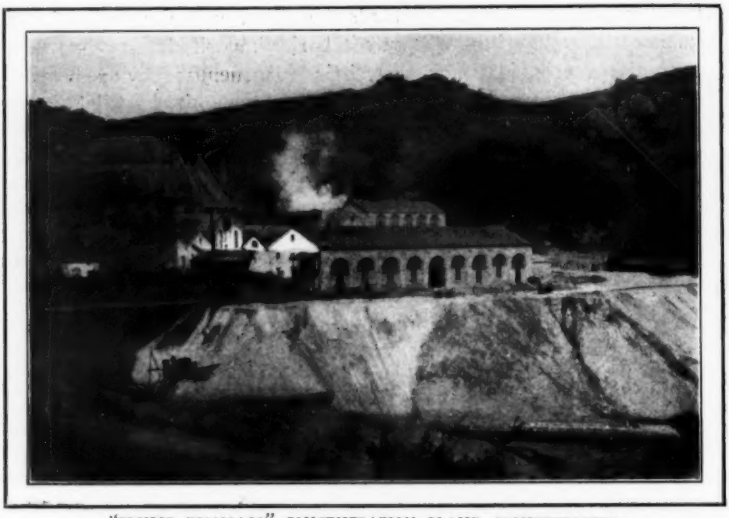
The mining operations are distributed over the principal vein and the secondary one. The ore is galena, accompanied in some places with blende. It tends to an arrangement in large masses or in layers situated almost vertically in the vein. The columnar masses of Colombi, S. Baroara, and the masses of so-called "N. 8." are celebrated above all; they have furnished for several years almost the entire production of the first concession. The galena of Montevecchio is argentiferous, as are all the Sardinian galenas, to a greater or less extent. The silver content varies from 1,000 to 250 grammes per ton of ore; it diminishes in going from east to west. so that the ores which contain the greatest amount of silver are found in the concession of Piccalinna. The lead in the ores of Montevecchio varies from 60 to 70 per cent. The occurrence of the galena in the veins varies in the different excavations. In some places the vein appears irregularly bordered with beautiful bands of galena, siderite, or pyrites, more or less large, and separated by quartz; while in other places breaks are found filled with pure galena in fragments with sharp angles, cemented together by quartz and siderite. In still other places, finally, traces of copper occur, and secondary formations of calamine. The Montevecchio formation is very interesting also from the mineralogical point of view, and it is deservedly well known by museums on account of its magnificent cerusites of silky lustre and its anglesites of superb emerald-green color. Conspicuous outcroppings of the principal vein, and very imposing ones from the secondary veins, rise in the range of hills that separate Montevecchio

from Guspini and Arbus. Towards the north, on the other hand, the truncated summits of the trachytic hills rise imposingly, among which occurs the outcropping so characteristic of Arcuentu; they are crossed here and there by euritic dikes, which are recognized easily by the regularity of their course.

THE MONTEVECCHIO MINES; PICCALINNA CONCESSION.

The concentration plant of Sanna, built in 1865, has undergone several changes, of which the last was intended to double its capacity and provide it with a special department for the treatment of blendes. The power is furnished by a 120-horse-power gas engine, which drives the different sections by means of friction clutches. A little gas-producing installation, provided with a purifier, produces the gas for the engine. The principal shaft, Sanna, is a short distance from the concentration works; it is the center of extraction of the second concession, situated at an elevation of about 262 metres. The surface works, like those of the third concession, have a two-cylinder hoisting engine in the upper story, which drives the shaft of the hoisting drums by gearing. A horizontal engine, also acting through gearing, drives the system of piston pumps, which lifts the water from the mine shaft. In the lower story are placed the boilers.

The ore undergoes a preliminary treatment for the purpose of separating the richest part, or that easiest to melt, which it would be a mistake to send to the concentration plant below; and also the poor



"PRINCE TOMMASO" CONCENTRATION PLANT, MONTEVECCHIO.

ore, which it is better to sort out as much as possible, so as to avoid the cost of subsequent treatment. This double operation is accomplished by dividing the material which comes out into three classes—fine, medium and coarse; the fine is concentrated by means of English scrubbers, the medium is carefully hand sorted, and finally the coarse is broken up with hammers, and the rich ore picked out from it by hand. For a large part of this work, which is carried on partly out of doors and partly under sheds, female and child labor is employed.

A cross road leads from Colombi to the shaft of S. Antonio nearby, which is provided with a fine hoisting engine and a well-managed installation of piston pumps. The depth of the shaft is 165 metres, and it serves for the extraction of ore from four different levels. To get an idea of the character of the works below ground, it is necessary to visit the regions of excavation by going down in the cages as far as to level of Ignazia, passing through a part of that gallery, descending again through the works to the level of Enedina, and returning from there to the shaft to ascend to the surface. At S. Antonio the material is subjected to the same operations as those at Sanna just described, except that the rock is very much harder and immensely more difficult to break with hammers, so that it has been necessary to substitute for them very heavy crushers of the Marsden type. The partly concentrated material from which the rich and the

poor ore has been separated is sent to a concentration plant called "Prince Tommaso"; views of the exterior and interior of these works are shown on this page and the page opposite. Near to it a new installation has been built for generating, by means of gas engines of the Letombe type, the electrical energy necessary for various purposes, and for electric lighting by the three-phase system.

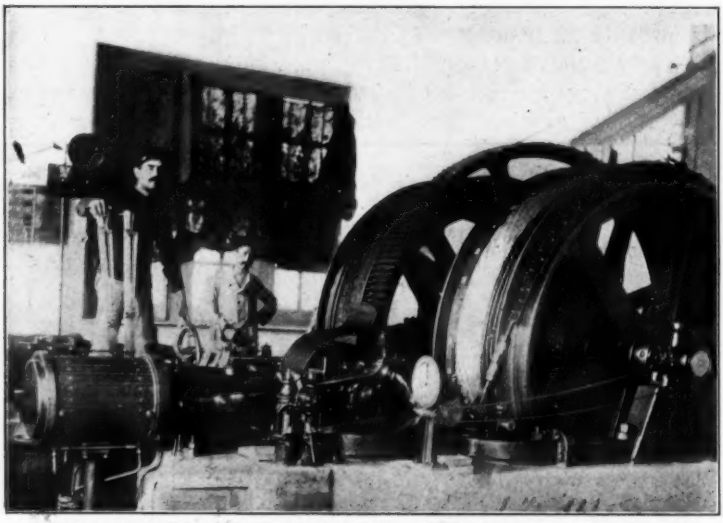
Upon entering the concentration works, the roll crushers are first met; then the revolving sieves or trommels, which classify the crushed material according to size of the pieces; and finally the mechanical sieves or riddles for gravity concentration. The highest of the concentrates are very rich and easy to treat in the smelter; the leanest of the waste is poor enough to be thrown out; there is, however, a proportion of partial concentrates, which must be returned to pass through the concentrator again; before this second treatment, however, the material is passed through a battery of thirty stamps instead of through the roll crushers. Revolving tables are used for the treatment of the slimes.

Nearby is the concession of Piccalinna, with its principal shaft at a height of about 230 metres. Its hoisting engine, shown on page 940, is worthy of mention. The ores or hand concentrates taken from

INTERIOR OF THE "PRINCE TOMMASO" CONCENTRATING WORKS, MONTEVECCHIO.

that concession are carried up on a little inclined plane to the concentration works, "Prince Tommaso."

Mine of Monteponi.—The mine of Monteponi (see illustration on page opposite) is situated 2.5 kilometres west of the town of Iglesias, upon a mountain of the same name overlooking the valley of Iglesias to the sea. It is connected to the town by the national road of Porto Botte, and by a branch of the railroad in continuation of the line, Cagliari-Iglesias. Half way up the southern slope the principal installations of the mine are grouped, forming an extensive industrial establishment, at which the tracks and railroads coming from all parts of the mine terminate. In the middle of this group of works are the mouths of the two principal shafts for extraction of ore and raising of water. A cable railroad with a slope of 33 per cent., covering a difference of level of 100 metres, connects the works with the railroad station and transports the cars as they come in or go out.



HOISTING ENGINE AT THE PICCALINNA CONCESSION, MINES OF MONTEVECCHIO.

The first authentic records of mining operations at Monteponi are given by the will of the feudal baron by the name of Berto de Santo Miniato, dated Dec. 3, 1324, in which mention is made of the excavation or mine "La Comunata" in Monte Paone. The first regular gallery was opened by Pierre Diana of Iglesias in 1744, and is called San Vittorio. It is at a height of 270 metres, and is now used for

the condensation of the fumes of the lead foundry. The Monteponi Company, which has its real headquarters at Turin, with Italian capital, was formed at Genoa on the 18th of June, 1850.

The ores of the mine are closely associated with dolomite and with lias, which is distributed sporadically at the surface in the dolomite. The ores which are worked are those of lead (galena, cerusite), and those of zinc (calamine and smithsonite), besides a little iron ore

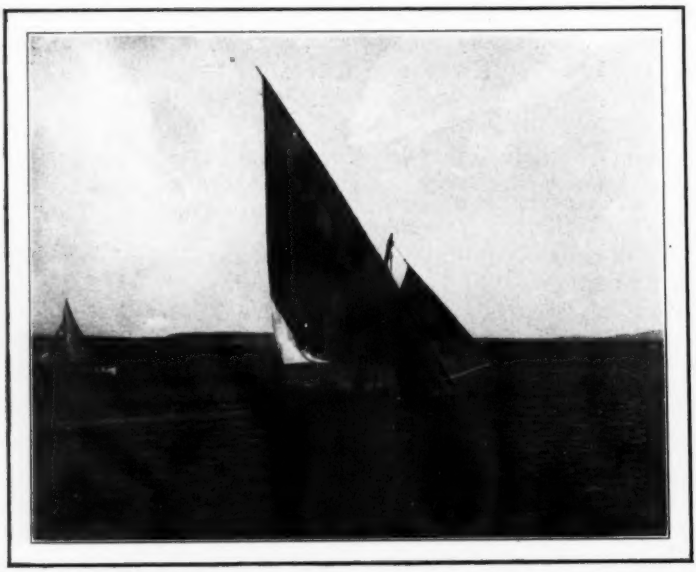
INCLINED PLANE, MONTEPONI MINES.

(limonite) used as flux for the lead. Galena preponderates at the southern part of the mine. The calamine tends to concentration towards the summit of the mountain, north of the lead-bearing region. On the sides of the mountains other secondary mining lodes are found.

The present production of the mines and the foundry at Monteponi is:—Lead ores about 6,000 tons, zinc ores about 14,000 tons, metallic lead about 4,000 tons, and metallic silver about 4,000 kilogrammes.

In the half-century between the foundation of the Monteponi Company and June 30, 1900, the total production has been:—Lead ores 319,882 tons, calamine (raw) 14,485 tons, calamine (calcined) 340,657 tons and zinc ores 355,142 tons, a total of 675,024 tons.

The annual mean has therefore been less than the present production, especially for the zinc ores. The total of the productions of



BOATS CARRYING THE PRODUCTS OF THE MONTEPONI MINE TO CARLOFORTE, FOR RESHIPMENT TO THE MAINLAND.

lead and zinc obtained from the mine is the result of a very extensive net-work of underground works, which have explored and worked the lode at numerous levels from the top of the mountain (358 metres above the level of the sea) down to the subterranean level of 15 metres above the sea. It is computed that altogether the works have about 80 kilometres of galleries, some being double.

The Monteponi Company at present employs about 1,600 persons, including laborers and administrative or supervising officers. The mine of Monteponi alone employs 1,100 laborers, while 400 more are distributed on the Monteponi-Porte Vesme railroad, in the lignite mines, and in two lead mines and two zinc mines of less importance than that of Monteponi. The laborers employed at Monteponi are divided as follows:—miners and overseers, 320; drivers and car men, 120; assigned to calcination and sorting, 90; laborers in the wash houses, 260; laborers in the lead and zinc foundries, 140; mechanics in the shops, 70; masons, assistants, watchmen, etc., 80.

The length of the working day is eight hours inside of the mine, and ten hours and a half outside of it, and in the ore-dressing establishments and shops. The labor inside is mostly done by piece work.

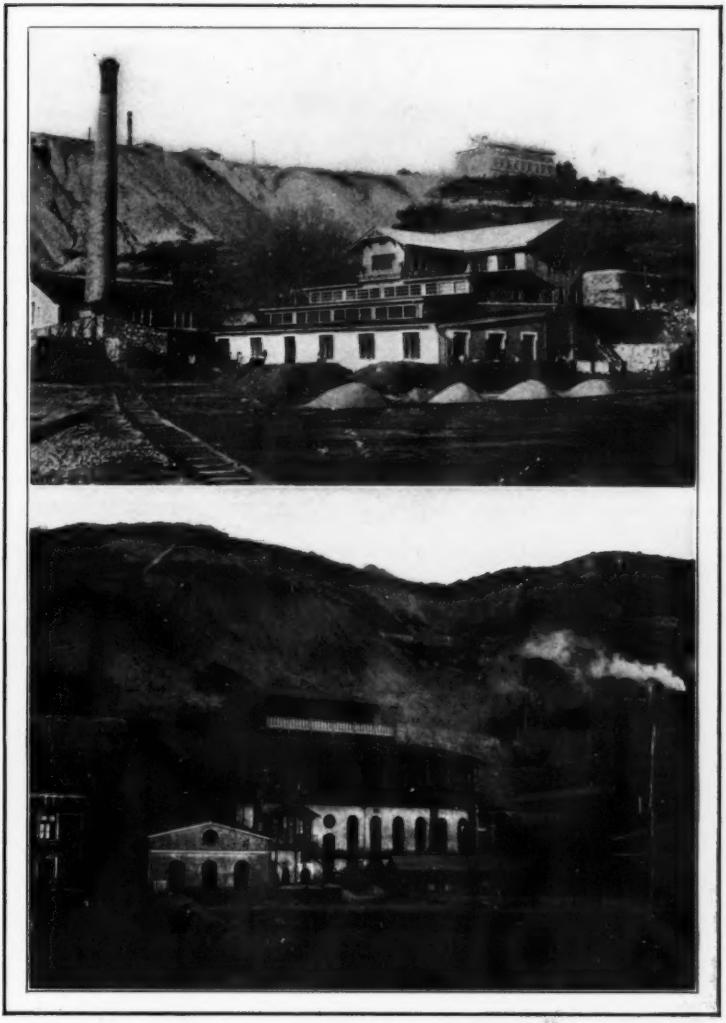
The first mine railroads, with iron rails at a gauge of 0.65 metres, and the first hand cranes were introduced by the first director of the mine in 1850. The first machinery for the concentration of poor ores dates from the same period. It consisted of a hydraulic wheel, revolving sieves, so-called "English" hand sieves (jigs), and conical tables (round buddles) for the sands. This embryonic concentration plant was in use till 1876. In 1863 the excavation of the principal shaft for the extraction of ore at the center of the mine was begun, at a height of 206 metres above the sea. Up to that time all the products of the operations had been taken from horizontal galleries. This shaft has now a depth of 211 metres, and six levels branch off from it, of which the lowest is 14 metres above the sea. The shaft has been provided with a 40 horse-power steam hoisting engine, with two cages or two-story hoists and safety appliances. In deepening the shaft the permanent level of water was reached at 70 metres above the sea, and the contest was undertaken with that element, which has not caused any disturbance. The dolomite which forms the greater part of the interior of the mountain, and even the metalliferous rocks of all the mines of the district of Iglesias, is rendered cavernous by the numerous hollows eaten out by solution in atmospheric waters which pass through. After having attempted to cope with the water first of all with hand pumps and pumps worked by horses, and then by small steam pumps, recourse was had in 1869 to a direct-acting steam pump with an internal cylinder diameter of 1.10 metres, and maximum stroke of 3.50 metres. Two sets of force pumps, 0.40 metres in diameter and two of suction pumps 0.30 metres in diameter, distributed along the shaft, completed the installation, which is capable of lifting 1,500 litres per minute and developing 130 horse power. But the insufficience of the pump described had to be admitted very soon, and others were applied so as to lift 21,000 cubic metres of water per day. In May, 1881, the attempt to overcome the waters of the bottom by means of pumps was definitely given up, in the expectation that the drainage tunnel already begun would offer them an outlet to a lower level. This gallery starts from the marshes of Fontanamare, at a height of 2.70 metres, and reaches the metalliferous dolomite at the west of Monteponi at a height of 6 metres, after crossing clayey schists, sandstones and limestones in the valley of Monteponi. It begins as a trench, for a length of 112 metres, and continues underground for 4,190 metres before reaching the dolomite and striking the first flow of water. The metalliferous dolomite was reached on March 8, 1885, and then a flow of water of 32,000 cubic metres per

day took place, which lowered the level of the water in the mine from 61.50 to 55 metres above the sea.

In the next year work on this tunnel was resumed, and it was prolonged to 4,252 metres, carrying a daily flow of water of 60,000 cubic metres. Finally, on August 2, 1889, an immense vein of water was opened, and all the works of the mine rapidly became dry. In the first twenty-four hours the flow reached 307,550 cubic metres; afterwards it diminished gradually to its present constant amount of about 110,000 cubic metres per day, or 40,000,000 cubic metres per year, representing the quantity of water annually absorbed by the metalliferous ground situated at the west of Iglesias. The total cost of this work was 1,920,000 lire.

LOADING ORE BOATS, PORTO VESME.

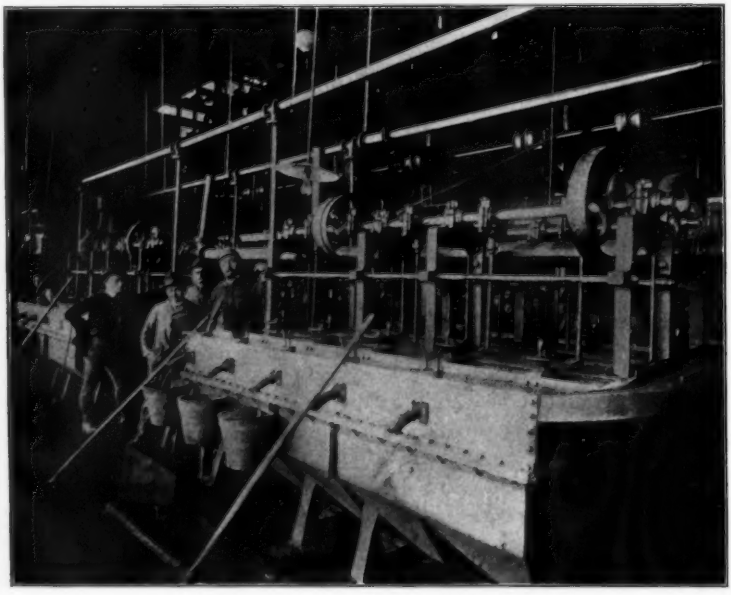
Up to 1870 transportation of the products of the mine was by carts, which carried them to the shore at Fontanamare, a distance of 8 kilometres, and from there by boats to Carloforte (page 942), where they were loaded into ships to be carried to the main land. The company decided very soon, however, to construct a narrow-gauge railroad of its own. The cost of construction of this line and of its equipment amounted altogether to 2,175,700 lire. In its course it touches three mines of lignite, of the Eocene period, which furnish a con-



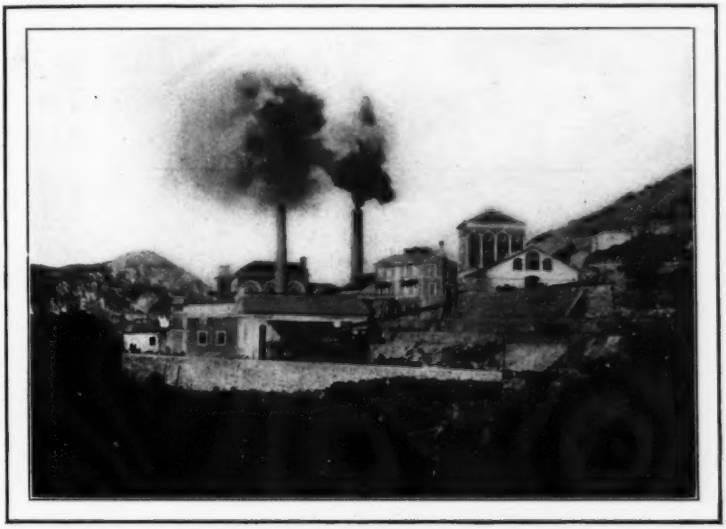
THE CONCENTRATION WORKS, MONTEPONI. THE UPPER FIGURE SHOWS THE ORIGINAL WORKS; THE LOWER, THE LATER CONSTRUCTION.

siderable return traffic. Porto Vesme (shown on page 944), where the railroad ends, near to the village of Porto Scuso, has a dock basin dug out in the marsh of Canelles, ample storage houses with a capacity of 6,000 tons of ore, and a harbor protected by rocks for a distance of 250 metres; vessels of a carrying capacity of 200 tons can reach the wharves.

The first mechanical concentration works (page 945), situated between the mine and the railroad station, were built in 1876, for the purpose of doing away with the numerous washings by hand in the treatment of the fine materials. In 1881 crushing machinery for the mixed ores was added to these concentration works; and in 1890 they were finally completed and equipped so as to be able to treat every kind of material. They are divided into two sections; the principal one consists of two oscillating separators, two vanners, twelve sieves and six vibrating tables; the second—the machine section—contains a crusher, two crushing rolls, an oscillating separator and six sieves. In 1884 a second concentration works began operation; it consists at present of three sections—one for treating rock as mined, containing three oscillating separators, two vanners, ten sieves and three



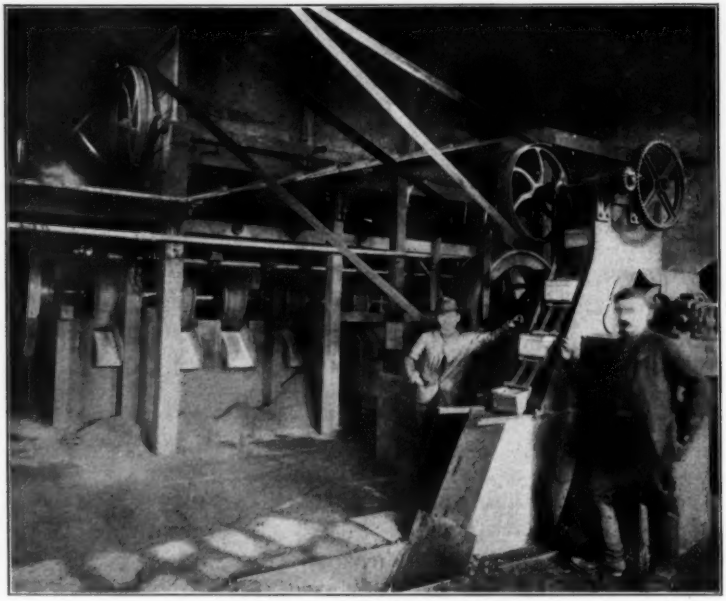
CALAMINE CONCENTRATORS, MONTEPONI.



THE MONTEPONI SMELTER.

vibrating tables; the second for crushing the mixed materials and separating the different ores from them, containing a Ferraris mill, an oscillating separator, six sieves and four vibrating tables; the third for the magnetic separation of the ores of iron and zinc, containing a magnetic separator with six electromagnets, and nine sieves. The first section treats three tons per hour, each of the other sections one ton per hour; 60 horse power is consumed. In 1887 the calamine concentration works (shown above and on the following pages), situated above those just described, and intended for the treatment of zinc ores from the upper part of the mine, was put into operation. In 1890 a magnetic concentrator was added to it, for separating mixtures of iron and zinc, which form a by-product of the calamine concentration works. The present equipment of these works consist of one crusher, eight grinders, four continuous vanners, eight separators (by which grades of separation of 1.5, 3, 5, 7.5, 10, 14, 20, and 30 millimetres are obtained), seventeen single sieves, eight double sieves, eighteen quintuple sieves, and three vibrating tables. The power required by the calamine concentration works is at present 120 horse power, while 20 horse power more are consumed by the magnetic separators and the rotary furnaces for roasting the concentrated ores of zinc. In each concentration plant a quantity of water circulates, serving to

HAND PICKING THE ORE, MONTEPONI.



ELECTRO-MAGNETIC SEPARATORS, MONTEPONI.

clean the materials, to effect the separation of the ores, and as a vehicle to carry off the clay or mud. If that water was thrown away after having passed through the works it would be necessary to provide at least 3,300 cubic metres of fresh water per day, which would have to be raised at considerable cost from the level of the sea. To prevent this expense, each plant is provided with large settling reservoirs for the waters containing suspended matter, and also with pumps for circulation; and the actual consumption is reduced to that of the water evaporated. The supply of water is maintained, and drinking water is provided for the works, by means of a double conduit 7 kilometres long, which comes from springs at the north of Monteponi.

LEAD SMELTING FURNACES, MONTEPONI.

In 1894 the lead and silver smelting works, near to the principal shaft (page 950) went into operation. It began with the treatment of easily reduced ores, with a production in the first year of less than 300 tons of lead; the output developed gradually in proportion as the personnel gained experience, and in the past year the production reached 4,200 tons, obtained partly from ores belonging to the mine and partly from purchased ores. The ore is first ground in a mill and then desulphurized and agglomerated in reverberatory furnaces. These roasting furnaces are four in number, two on the

BOTTOM OF THE MAIN HOISTING SHAFT, MONTEPONI.

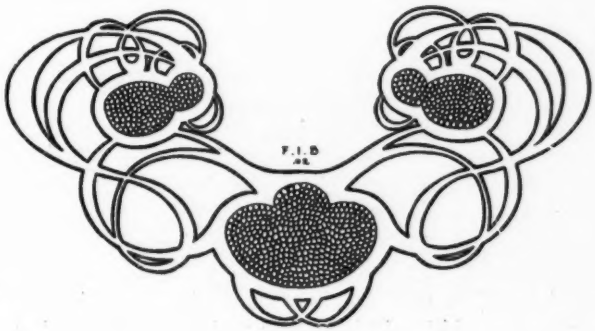
upper story of the foundry and two on the lower. One of the latter, smaller than the others, serves also for the treatment of certain secondary products, such as the metallic products from the blast furnaces. The agglomerated material in the roasting furnaces passes into the blast furnaces, of which there are two, one with six and the other with eight tuyeres.

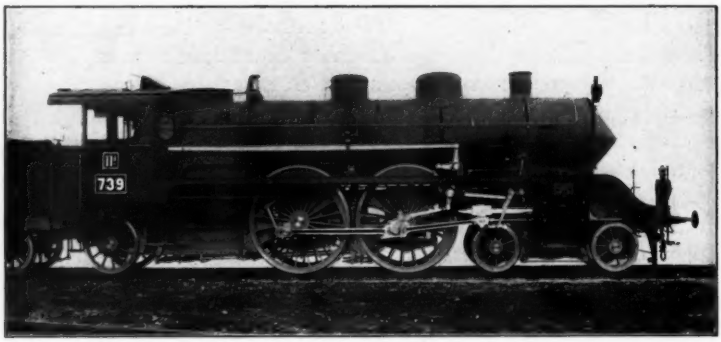
The air is supplied to these furnaces by two blowers of the Enke type, each driven by an individual motor. Ordinarily one of the two is in operation and delivers the air under a pressure or 30 millimetres of mercury. The lead obtained from these furnaces passes into a tempering furnace to free it from impurities, and then goes to one of the two hemispherical heaters, where the silver is extracted by the zinc process. Two products are obtained from these silver-extraction heaters: The triple alloy, Zn—Pb—Ag, which passes to the silver section, and the desilverized lead. The latter passes to a final furnace, in which it is purified from such zinc as it may still contain, and from which it flows into a stock heater, from which it is cast by means of an iron siphon into moulds arranged in a semicircle around the heater, and the pigs obtained in this way are carried to the store house. The triple alloy is treated in a graphite crucible; the zinc distils and is recovered in part; the lead residue, rich in silver, passes

finally to the cupel. In 1889 a zinc furnace was added for the purpose of extracting the zinc from the lead-bearing calamines and using the residues as ores of lead, which pass to the lead foundry. The calamine reduction furnace, with 180 crucibles, has a capacity for treating 7,200 kilogrammes of ore per day.

As an accessory of this industry a complete factory for refractory materials has been built, provided with machinery, grinders, kneaders, hydraulic presses, etc., for the manufacture of all kinds of refractory products, crucibles, zinc condensers, moulded pieces of every shape, and refractory bricks; there are immense dryers, roasting furnaces with a capacity of 25,000 bricks, and motive power of 40 horse power. These metallurgical works with their accessories have a present value of 700,000 lire. Besides commercial lead, they produce refined silver, zinc, and hard lead.

A machine shop with foundries for iron and brass completes the series of industrial installations of the Monteponi mine, and serves for the repair of the varied machinery in use, as well as for the construction of new machinery.





FOUR-CYLINDER COMPOUND LOCOMOTIVE BY J. A. MAFFEI, MUNICH.

THE DEVELOPMENT OF THE COMPOUND LOCOMOTIVE IN ENGLAND.

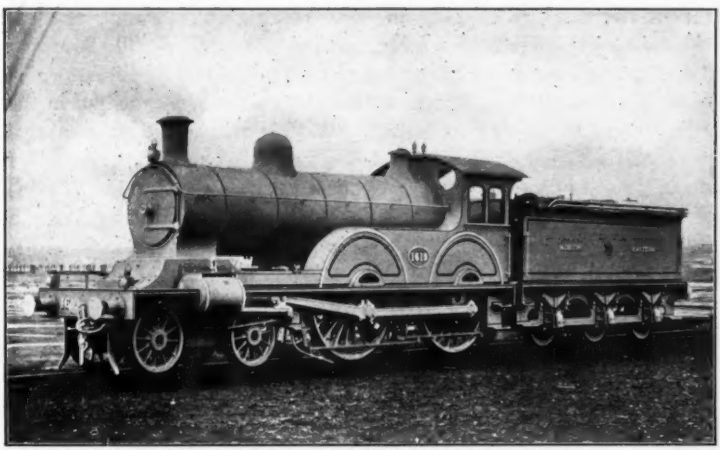
By W. E. Dalby.

Professor Dalby's articles are designed to be a brief discussion of the mechanical aspects of compounding as applied to the locomotive, and a rapid survey of the actual development which has taken place in the quarter-century since its first introduction. This first section deals with the work of Mr. Webb, the foremost of the English engineers who have worked on the problem. A concluding section will treat of other designers. The illustrations widen the field and show the latest products of America and the Continent as well as Great Britain. —THE EDITORS.

THERE is perhaps no question about which there has been so much difference of opinion amongst locomotive engineers as that of compound locomotives. All are ready to admit that in certain circumstances a compound engine is more economical with regard to fuel and water than a simple one, but since, in general, compounding means increased mechanical complexity and increased maintenance costs, locomotive engineers are certainly not unanimously of opinion that the saving is a real one.

The first object that a locomotive engineer has in view is to build an engine which will keep time under adverse weather conditions and with a stated maximum load. The weather conditions are so variable that an engine designed to meet this requirement must have reserve boiler power and large grate area with correspondingly large heating surface, and for fast running, or rather high piston speeds, plenty of room in the pipes and ports for the steam to get out of the cylinders. If steam is to be had from the boiler, there is

usually less difficulty in getting it into the cylinder than there is in getting it to exhaust freely. The second object of a designer is to design the engine so that whilst fulfilling the first condition it is economical with regard to fuel. If the second condition is fulfilled at the expense of the first, the economy obtained by decreased fuel consumption is false. Compound locomotives are stated to save about 14 per cent. of fuel, corresponding to about 5 pounds of coal per mile, and taking this at 10 shillings per ton the saving is about a farthing per mile. That is, one passenger is equivalent to four times the saving effected by compounding, because he pays at least a penny per mile. From the economical point of view therefore it is more profitable to cultivate passengers by excellent and unfailing time keeping. If the two conditions of design can be fulfilled by a compound, then, weight for weight, the compound engine is more powerful, because the size of the boiler has been virtually increased in the compound engine to the extent of the saving of steam effected. These considerations show what a difficult problem the locomotive engineer handles when dealing with compound locomotives. "Is it worth while to compound?" is the question which forces itself into notice. Some eminent locomotive engineers have decided that it is worth while, and that economy in fuel may be obtained without sacrificing efficiency in other respects. Others, equally eminent, believe that it is not worth while, and think that a simple engine is to be preferred for the peculiar conditions of locomotive work.



THREE-CYLINDER COMPOUND ON THE NORTH EASTERN RAILWAY OF ENGLAND.

The object of this article is to state a few principles by means of which the performance of a compound engine may be compared with that of a simple locomotive, and to give a brief account of the leading types which have come into use in Great Britain.

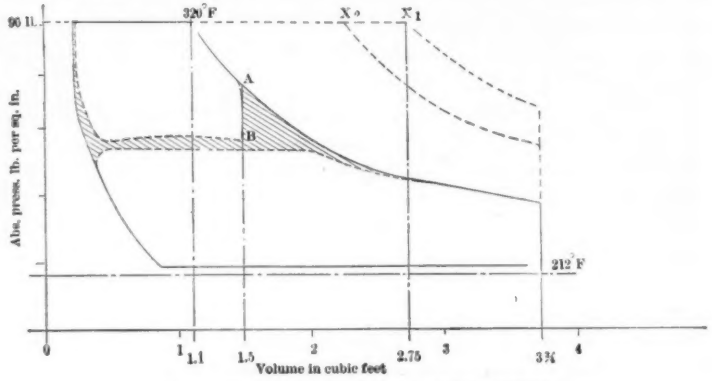


FIG. I. INDICATOR CARD FROM A SIMPLE ENGINE.

First, let us see what the nature of the problem is by the discussion of a numerical example. Consider the indicator card, Figure 1, taken from a simple engine. It is calibrated for pressure and volume so that the absolute pressure and the corresponding volume of steam shut in the cylinder can be read off at any point in the stroke. At cut-off the pressure is 90 pounds per square inch absolute and the volume 1.1 cubic feet. A reference to the steam tables will show that the volume of one pound of steam at 90 pounds pressure is 4.8 cubic feet. The inference is, therefore, that the weight of steam shut in the cylinder at cut off is 0.23 pounds. Now an independent measurement of the boiler feed disclosed the fact that the actual weight of steam passed into the cylinder per stroke was .0575 pounds. If none of this had been lost, the cut-off could have been arranged for a volume of 2.75 feet shown by the point X_1, on the diagram, since this is the volume corresponding to the actual weight of steam fed to the cylinder per stroke. The expansion curve would then have been somewhat as sketched, giving a large increase of work per stroke. The loss—that is, the difference between the actual weight fed to the cylinder and the weight accounted for by the indicator diagram—is usually put down to initial condensation, though probably a proportion of it is due to steam leaking through from the steam to the exhaust side of the slide valve. The cut-off point (and also every

point on the expansion curve) on an indicator card from any steam engine is of necessity accompanied by a point X_1, giving the volume of the steam corresponding to the actual weight fed to the cylinder at cut off. The nearer X_1 approaches the cut-off point, the greater the economy of the engine. It has been found experimentally that as the cut-off is made earlier in the stroke the point X_1 moves farther away. In other words, increased expansion is accompanied by increased difference between the steam fed to the cylinder and the steam accounted for. There is, therefore, one particular ratio of expansion for a given condition of working where the gain due to expansive working is neutralised by the loss due to condensation. Another way of looking at the same thing is to consider the temperature variation of the steam. Observe that the temperature of the steam at cut-off is 320 degrees F., and at exhaust 212 degrees F., a difference of 108 degrees. It has been found by experiment that if the expansion of steam is carried out in stages, limiting the temperature difference in each cylinder to about 70 degrees, the condensation losses are considerably reduced. Let us consider now how the expansion of the steam may be carried out in two stages so that the same degree of expansion is maintained. Suppose steam to be admitted and cut-off as before when the volume has reached 1.1 cubic feet, Figure 1. Suppose further that expansion stopped when it has reached the point A on the curve, and that the pressure drops to the point B when communication is opened to the exhaust, which now takes place into a receiver of pipes communicating with the second cylinder in which the expansion is to be completed. The volume of the first cylinder must evidently be 1.5 cubic feet for this operation to be possible, and since the final volume is to be the same as in the case of undivided expansion, the volume of the low-pressure cylinder will be equal to the volume of the cylinder in which this undivided expansion can be carried out, namely, 3¾ cubic feet. The approximate shape of the indicator-diagram card is sketched in the figure. The whole ratio of expansion is the same as before, and is, (as always in a compound engine, no matter how many stages the expansion is divided into,) the ratio of the volume of the low-pressure cylinder to the volume of steam in the high-pressure cylinder at cut-off. By so dividing the expansion, the ratio of expansion and the temperature range in each individual cylinder is very much reduced so that the point X_1 should be nearer the cut off point. Considering the whole expansion it might move to a position X_2, indicating that a greater proportion of work is obtained from the cylinder feed per stroke. The effect of clearance

and compression is neglected in the above explanation but it is inconsiderable and does not affect the general principle. Compounding therefore enables a range of expansion to be used without incurring so much loss by condensation as would be the case if the same range of expansion were carried out in a single cylinder. Figure 2 exhibits the volume of the high-pressure cylinder reduced to the stroke of the low-pressure cylinder. It would appear from the above that the volume of the high-pressure cylinder is largely a matter of choice. And so it is—but choice tempered with experience. The relative volumes are commonly arranged so that the work done in each cylinder is about the same. Although there is a reduction in condensation by compounding, the transfer of the steam from one cylinder to another cannot be made without loss. The work so lost in the hypothetical case Figure 1 is indicated by cross hatching; but notwithstanding this, with a properly arranged cylinder ratio and valve movement there is gain in economy. To further illustrate this point, Figure 3 exhibits diagrams taken from a North Eastern compound locomotive reduced to the same volume and pressure scale. The cross hatching indicates the work lost by the transference of the steam from one cylinder to another assuming that the expansion curve sketched in through the point of cut-off in the high-pressure cylinder would be that followed if the whole of the expansion were carried out in the low-pressure cylinder. This diagram also shows that the work is divided about equally between the two cylinders.

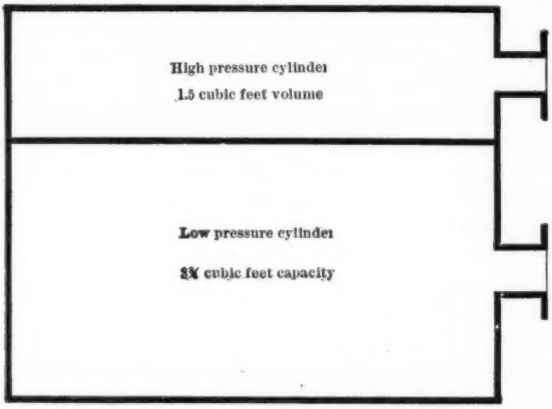


FIG. 2. VOLUME OF HIGH-PRESSURE CYLINDER REDUCED TO STROKE OF THE LOW-PRESSURE CYLINDER.

In the comparison of a simple with a compound engine with regard to their power, the combined volume of the low-pressure cylin-

ders must be compared with the combined volume of the cylinders in a simple engine. Thus a simple engine with two cylinders each 18 inches in diameter and 24 inches stroke is equivalent to a two-cylinder compound with one low-pressure cylinder 25½ inches in diameter. In the design of a compound engine for locomotive work there is one point which differentiates the problem entirely from the corresponding problem in marine work. The locomotive has to start with it full load on—in fact, the pull at the drawbar is greatest when starting and for a few seconds it is necessary to take steam through as much of the stroke as possible in the simple engine. In a compound engine it is impossible to take steam to a greater extent than that permitted by the volume of the high-pressure cylinder. Various starting devices are used to overcome this difficulty; generally arrangements are made to admit steam directly to the low-pressure cylinder through some form of reducing valve. The best solution of the problem of compounding a locomotive would be the one which allowed the engine to work as a simple engine at starting, and possibly when working up heavy banks, taking a large quantity of steam per stroke, which could be changed to compound working at high speeds, with a high grade of expansion taking a small quantity of steam per stroke but as much per second as the boiler can supply.

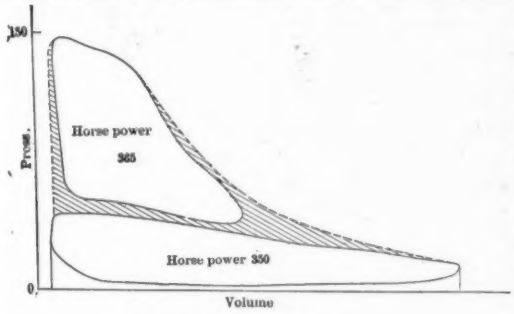
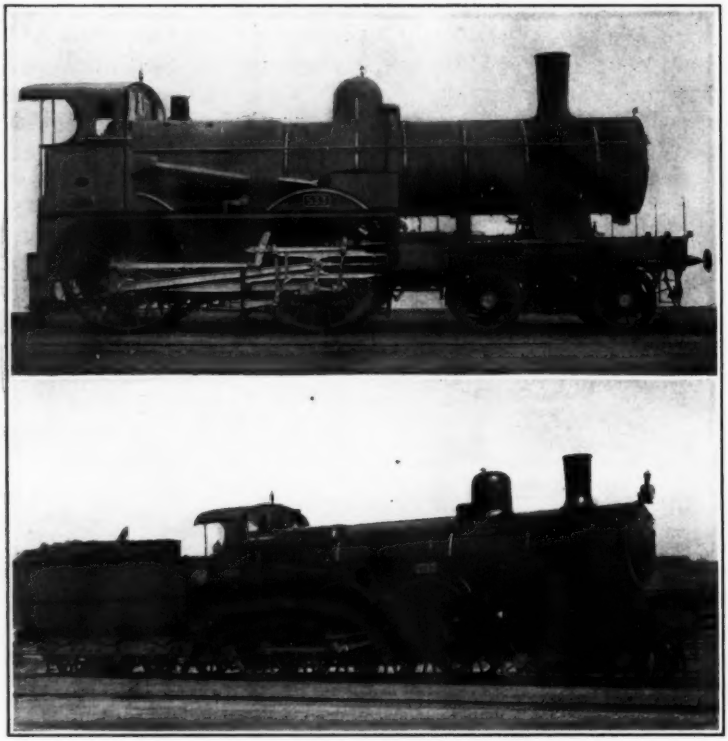


FIG. 3. DIAGRAM FROM NORTH EASTERN COMPOUND.

Turning now to the consideration of what has actually been done in Great Britain; Thomas Craddock invented a compound condensing locomotive in 1846, and in 1849 John Nicholson invented what he called a "continuous expansion" locomotive. His idea was that the whole of the exhaust steam was not required for the blast; consequently between one-half and two-thirds of the steam supplied to the cylinder was allowed to exhaust into the blast pipe at a pressure considered necessary to produce the draught, the remainder being led to a second cylinder where it expanded to a lower back pressure.

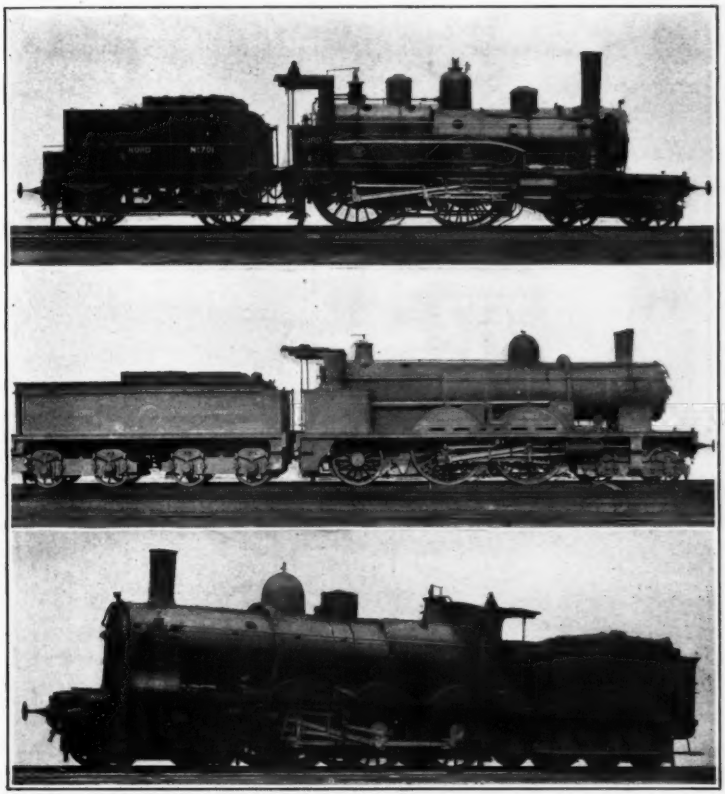
This engine was a compound in the sense that expansion was carried out in two stages, but it is doubtful whether it should be called a compound locomotive, because the aim of Nicholson was quite different from the aim of the designer of a compound engine. Nicholson's object was to expand down to a low back pressure and yet to maintain a high-pressure blast, and in designing the necessary arrangement he incidentally arrived at two cylinders. He apparently had no notion of carrying expansion out in two stages in order to limit the temperature difference in the two cylinders and thus save initial condensation.

The first true compound locomotive dates from 1876, when an



COMPOUNDS OF THE WESTERN RAILWAY OF FRANCE.

Above is a four-coupled four-cylinder bogie locomotive, cylinders 34 and 53 by 64 centimetres, weight 50 tons. Below is a six-coupled four-cylinder bogie locomotive, cylinders 35 and 55 by 64 centimetres; weight 65 tons.



A GROUP OF COMPOUNDS, NORTHERN RAILWAY OF FRANCE.

At the top is the 701, designed by de Glehn, and put into service in 1886. It has cylinders 33 and 46 centimetres diameter, 61 centimetres stroke, and weighs 41.45 metric tons. Next is du Bousquet's "Exposition" type 2642, designed in 1902 to maintain a speed of 100 kilometres an hour with a 200-ton train on a 0.5 per cent. grade; it has cylinders 34 and 56 centimetres by 64 centimetres and weighs 64.4 tons. At the bottom is a six-wheel coupled engine for fast freight and coal trains, hauling 950 tons on a 0.5 per cent. grade and 600 tons on a 1 per cent. grade at 40 kilometres an hour. Cylinders 35 and 55 by 64 centimetres, weight 58.57 tons.

engine was constructed at the Creusot Works for the Bayonne and Biarritz Railway Company on a plan proposed by Mr. Mallet. The first stage of the expansion in this historic engine was carried out in a cylinder whose volume was 0.72 cubic feet, and the second in a cylinder whose volume was 2 cubic feet capacity, the engine thus being equivalent to a simple engine with two cylinders each one-cubic-

foot capacity. The pressure was 140 pounds per square inch. The trials with this engine proved that the two blasts per revolution from the low-pressure cylinder were capable of producing a draught sufficient to give plenty of steam.

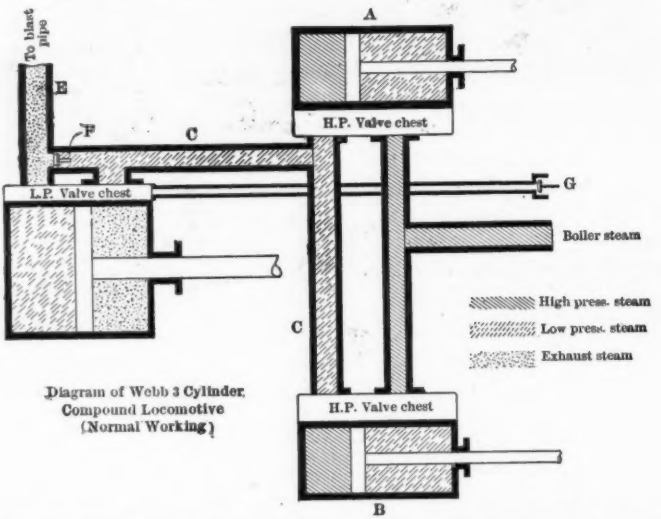
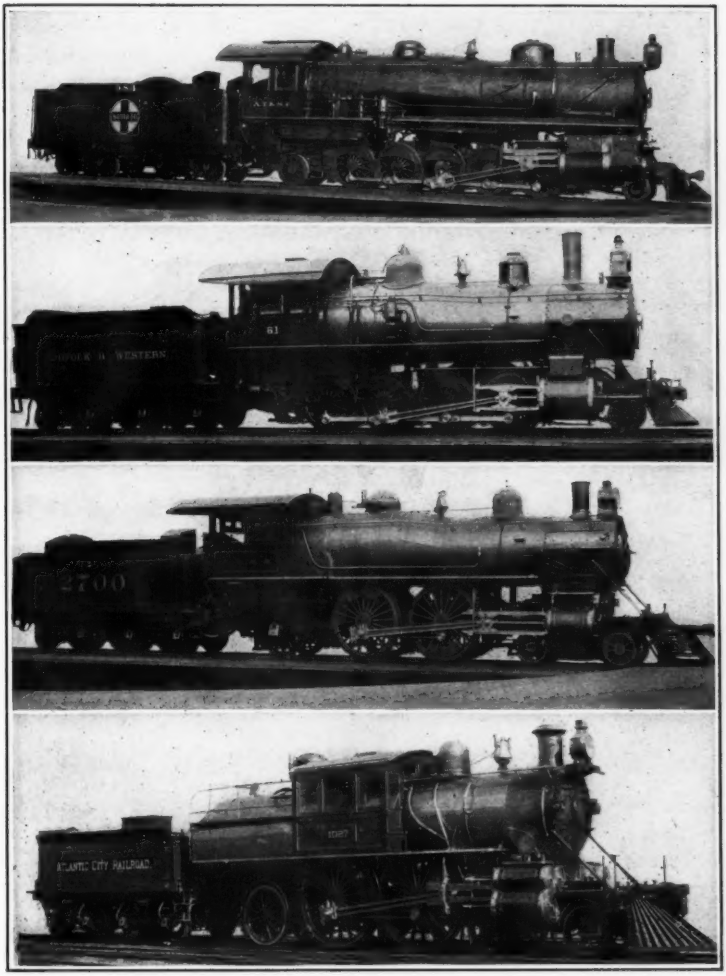


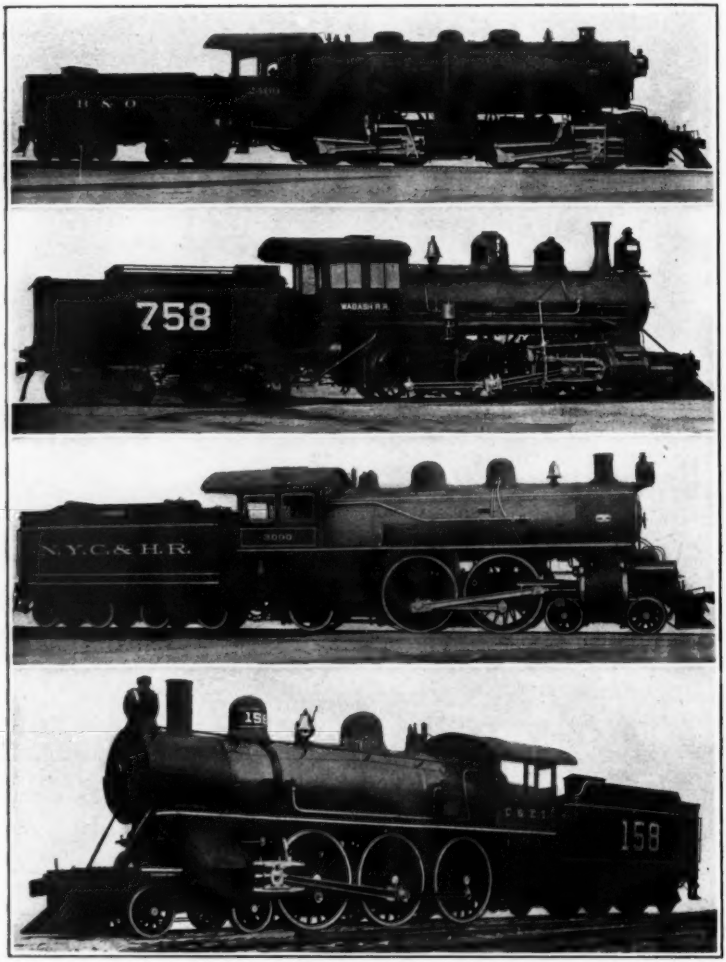
FIG. 4. DIAGRAM OF CYLINDER ARRANGEMENT OF WEBB THREE-CYLINDER COMPOUND.

The first true compound engine in England appeared in 1878 on the London and North Western Railway. Mr. F. W. Webb converted an ordinary single-wheeled outside-cylinder passenger engine into a compound of the Mallet type by the simple expedient of bushing one cylinder to 9 inches diameter, leaving the other to act as the low-pressure cylinder. This engine ran regularly on the Ashby and Nuneaton branch of the railway, and the results obtained led Mr. Webb to the design of the two-stage expansion three-cylinder compound which has since been associated with his name. The diagram Figure 4 indicates the arrangement. Two high-pressure cylinders, A and B, placed outside the frames, drive directly onto the trailing axle, the cranks being placed at right angles. The connections shown in the diagram indicate that the cylinders, so far as the expansion of steam is concerned, are to be regarded as one in which the first stage of the expansion is carried out. To use an electrical term, they are connected in parallel. The steam after partly expanding in these is transferred through the pipe C to the steam chest of a single low-



COMPOUNDS BY THE BALDWIN LOCOMOTIVE WORKS—BURNHAM, WILLIAMS & CO., PHILADELPHIA.

At the top, the Santa Fe 934—tandem-compound, "Santa Fe type"—cylinders 19 and 32 by 32 inches; 58.5 sq. ft. grate and 4,796 sq. ft. total heating surface; weight of engine 287,240 lb. Next, a cross-compound for the Norfolk & Western, cylinders 23 and 35 by 32 inches; 34.8 sq. ft. grate and 2,788 sq. ft. total heating surface; weight 186,000 lb. The third is a four-cylinder balanced compound, C. B. & Q. Ry., which recently hauled a 7-car train from McCook to Akron, 214½ miles, in 241 minutes running time. At the bottom is the Vauclain four-cylinder compound "Atlantic type," cylinders 13 and 22 by 26 inches; total heating surface 1,835.1 sq. ft.; weight 142,900 lb.



COMPOUND ENGINES, AMERICAN LOCOMOTIVE COMPANY, NEW YORK.

The topmost is a Mallet articulated for the B. & O., cylinders 20 and 32 by 32 inches; 72.2 sq. ft. grate and 5,585.7 sq. ft. total heating surface; weight 334,500 lb. Next is a Richmond compound mogul, Wabash R. R., cylinders 20½ and 32½ by 28; 31.97 sq. ft. grate and 1,578 sq. ft. total heating surface; weight 129,500 lb. Third is a Cole balanced compound, cylinders 15½ and 26 by 26 inches; 50.3 sq. ft. grate and 3,446.1 sq. ft. total heating surface; weight 200,000 lb. At the bottom is a 10-wheel compound, C. & E. I., cylinders 22 and 34 by 26 inches; 35.87 sq. ft. grate and 2,380.8 sq. ft. total heating surface; weight 174,400 lb.

pressure placed between the frames, and in this cylinder completes its expansion, finally exhausting into the blast pipe E. It will be seen therefore that the engine consists so far as the mechanical arrangement is concerned of an outside single of the ordinary type and a one-crank inside single engine in combination. There are no coupling rods. Consequently the two crank axles are at liberty to take up any angular relation to one another they please. One of the advantages claimed for this type was that it combined the advantages of a coupled engine with the freedom of running peculiar to the single engine. The pipes transferring the steam from the high- to the low-pressure cylinder are coiled round the inside of the smoke box in order that the steam as it passes through them may pick up what heat it can from the smoke-box gases.

It will be gathered from the diagram that the engine must in general start from the high-pressure cylinders alone. It may happen, however, that the low-pressure engine has stopped so that the slide valve covers both steam ports, in which case the exhaust from the high-pressure cylinders cannot get away, and if in addition the high-pressure wheels should slip, the steam accumulating in the pipe C would soon increase in pressure to such an extent that the engine would be locked, at it were. To avoid this difficulty a valve F, operated by the driver, opens a communication to the blast pipe and then the engine works as a two-cylinder simple. The driver can also introduce boiler steam direct to the low-pressure valve chest through the small valve G. A sketch of the actual arrangement of the valves F and G is shown in Figure 5.

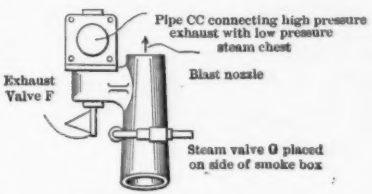
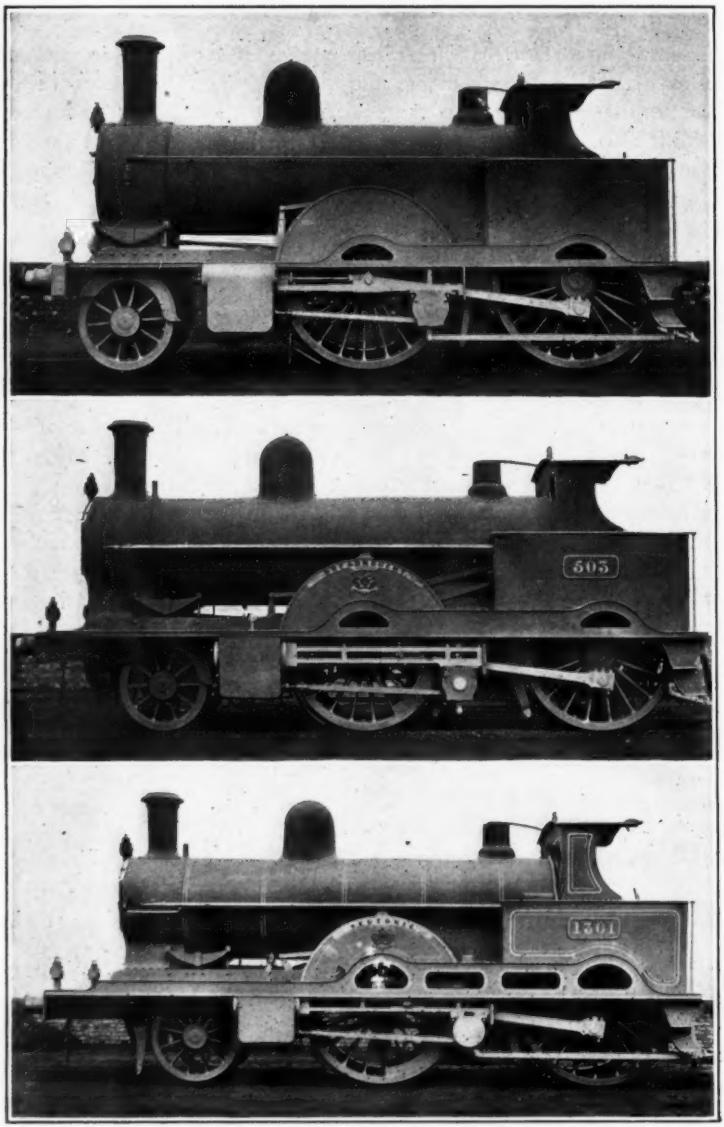

Pipe CC connecting high pressure exhaust with low pressure steam chest
Blast nozzle
Exhaust Valve F
Steam valve G placed on side of smoke box

FIG. 5. WEBB STARTING VALVE.

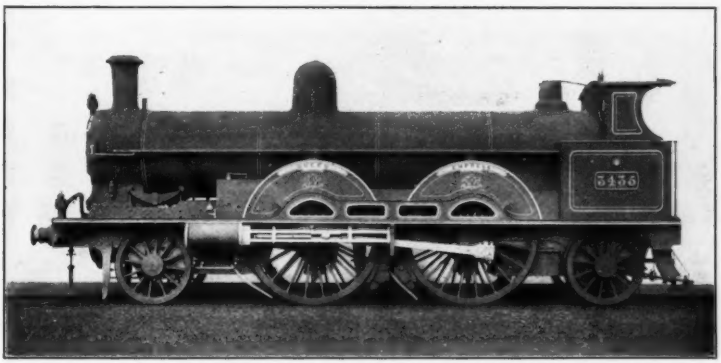
The first engine of this type, called "Experiment," was built in 1882. The high-pressure cylinders were each 11 inches diameter and 24 inches stroke, the low-pressure cylinder being 26 inches diameter and 24 inches stroke. The driving wheels were 6 ft. 6 inches diameter. A photograph of this engine is shown on page 964. Subsequently twenty-nine engines were built like her, with the single exception that the high-pressure cylinders were increased to 13 inches diameter. These were followed in 1884 by forty more, the "Dreadnought" class, with cylinder diameters enlarged in the case of the high-pressure to 14 inches, and the low-pressure to 30



WEBB'S EARLIER COMPOUND LOCOMOTIVES.

At the top is the first he built—the "Experiment," of 1882; next is the "Dreadnought," of 1884, with larger cylinders (14 and 30 inches); at the bottom is a later modification—the "Teutonic"—with larger drivers.

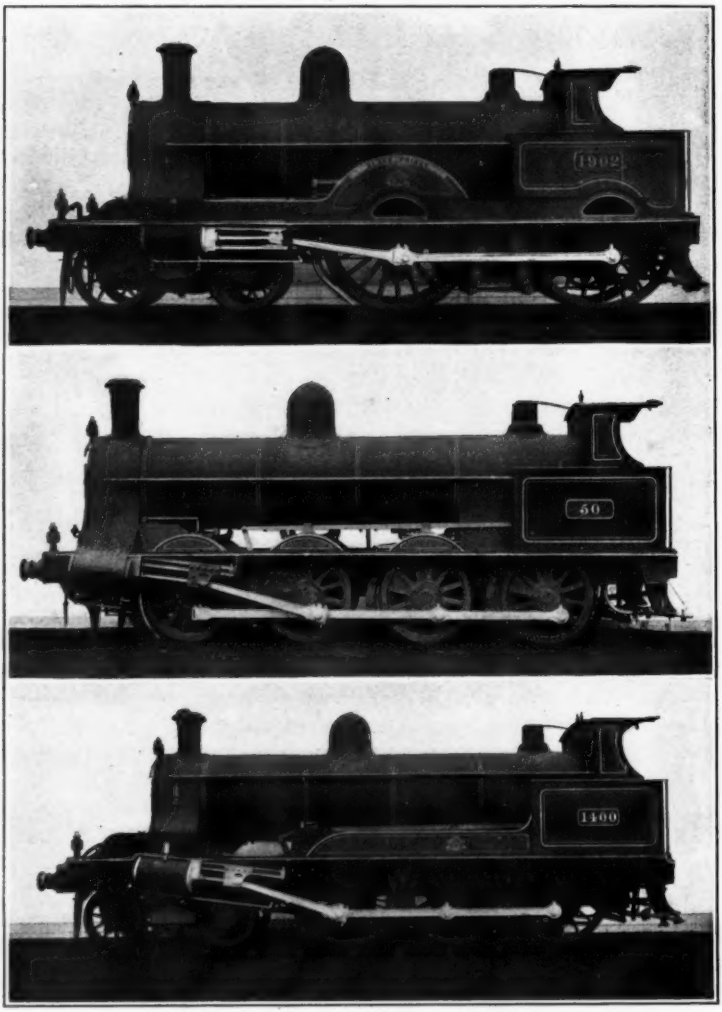
inches, the strokes remaining at 24 inches, but the wheels reduced to 6 feet 3 inches diameter. The boiler was increased in size and there were minor alterations made in details as will be gathered from the view, page 964. Then came ten of the Teutonic class, shown at the bottom of the page opposite, differing from the Dreadnoughts mainly, in having 7 feet 1 inch driving wheels. These were followed by ten having 15-inch high-pressure cylinders and known as the Greater Britain class. The most striking characteristic of this class, one of which is shown just below, is the long boiler, caused by the introduction of a kind of combustion chamber in the barrel about midway between the tube plates thus dividing the tubes into a leading and trailing set. Ten more of this type were built, the John Hick class, in which the driving wheels were reduced



THE "QUEEN EMPRESS," ONE OF WEBB'S "GREATER BRITAIN" COMPOUNDS.
Cylinders 15 and 30 inches, stroke 24 inches, drivers 75 inches. The engine has a combustion chamber midway of the barrel, dividing the tubes into two sets.

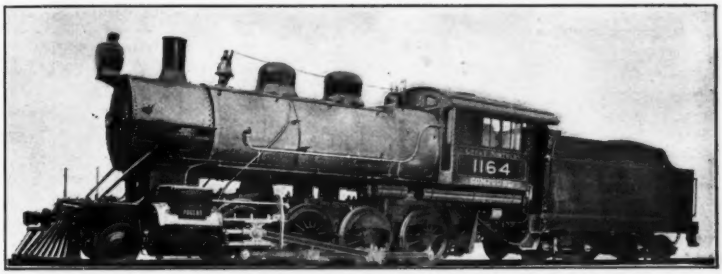
to 6 feet 3 inches diameter. Meanwhile the system had been applied to goods engines, but here the wheels were coupled and the cylinders were arranged together at the leading end to drive onto one axle. The two outside high-pressure cranks were placed at 90 degrees with each other and the low-pressure inside crank bisected the re-entrant angle between them. The cylinders were, high-pressure 15 inches diameter by 24 inches stroke, low-pressure 30 inches diameter and 24 inches stroke. Eighty-one engines of this class were put into service.

It may be mentioned that the Experiment and Dreadnought class were fitted throughout with the Joy gear. In the Teutonic class the Joy gear was retained for the high-pressure cylinders but was replaced on the low-pressure engine by the single loose-eccentric gear



WEBB FOUR-CYLINDER FOUR-CRANK COMPOUNDS.

The uppermost is the first of the class, brought out in 1897; in the middle is a freight engine, compounded in the same way; at the bottom is one of Mr. Webb's latest engines of the same type, designed for freight traffic.

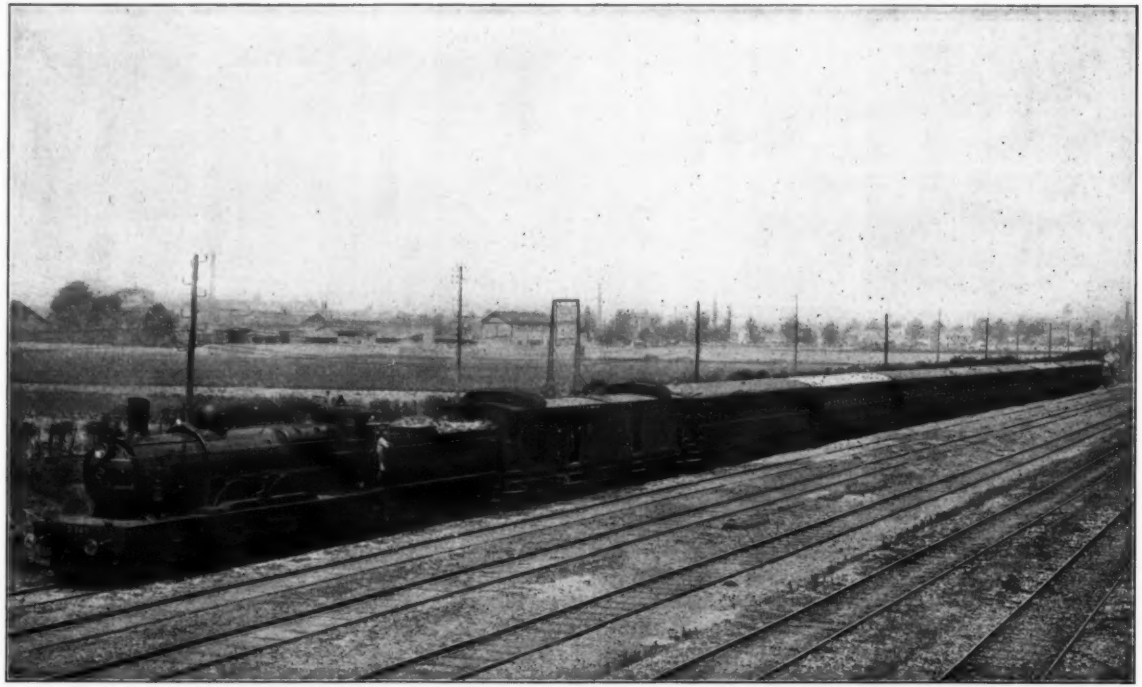


CONSOLIDATION COMPOUND BUILT BY ROGERS LOCOMOTIVE WORKS FOR THE GREAT NORTHERN RAILWAY.

Cylinders 22 and 33 by 32 inches; 35.45 sq. ft. grate and 2,812 sq. ft. total heating surface; weight 194,000 lb.

so that the engine really reversed entirely by the high-pressure cylinders. The succeeding engines were fitted with the Stephenson link motion for the high-pressure cylinders and the loose-eccentric gear for the low-pressure.

In 1897 Mr. Webb made a new departure with four-cylinder four-crank compounds. Connecting rods were again introduced, and the four cylinders drive directly onto one axle. The engine, so far as the steam distribution is concerned, consists of two two-cylinder compound engines placed side by side. The outside high-pressure cylinder and the adjacent inside low-pressure cylinder on the one side form one engine, the corresponding cylinders on the other side forming the second engine. Each engine drives cranks placed at 180 degrees, the 180-degree pairs being placed at 90 degrees. The high-pressure cylinders are each 15 inches diameter and the low 20½ inches, the strokes of all 24 inches. The high-pressure cylinders have piston valve, the low-pressure balanced slide valves. The Joy valve gear is used to work the low-pressure valve direct, and the valve spindle is extended through the leading end of the valve chest and gearing with a lever works the high-pressure valve. Thus one valve gear is made to operate the two valves. There are therefore only two gears for the four cylinders. The steam pressure used in this type is 200 pounds per square inch. The upper figure opposite shows the first of the class, the "Black Prince," and the next an 8-wheeled goods engine compounded in a similar way. Mr. Webb's last contribution to locomotive engineering is the handsome six-coupled compound goods engine shown at the foot of page 966. It is of the four-cylinder type, the high and low-pressure cylinders being respectively 15 and 20½ inches diameter and 24 inches stroke, and the wheels 5 feet 6 inches diameter.



THE EXPRESS FROM CALAIS TO PARIS, NORTHERN RAILWAY OF FRANCE, DRAWN BY A NORD COMPOUND.
The train is composed of eight coaches and a baggage car. It is 640 feet long, and weighs 300 tons (metric) behind the engine, which itself weighs 109 tons.

THE ELECTRIC EQUIPMENT OF WORKSHOPS AND FACTORY BUILDINGS.

By Percival Robert Moses.

In the following article Mr. Moses summarizes briefly the typical manufacturing uses to which electricity may be applied, the main essentials of the apparatus and installation required in the various instances, and the characteristics of the several types of motors, indicating their adaptability to the various kinds of duty for which they may be installed. —The Editors.

THE applications of electricity in factories and in other buildings used for manufacturing purposes are continually increasing both in quantity and wideness of scope. Electricity is used for lighting, for power, for high-temperature heating (replacing gas), for chemical and metallurgical processes, and for signalling and transmission of intelligence. The great advantage of electricity for power transmission has been demonstrated in many different ways, and I will merely touch on the more valuable features such as its flexibility and ease of transmission, cleanliness, reliability, elasticity in application, its protective features, and the ease with which it is measured, all of which are generally equal, if not superior, in importance to the possible saving in fuel by reduction in friction losses.

The flexibility of the electric system with its readily removable wires and motors, and the absence of any fixed location of countershafting, has been enlarged upon many times; it offers to the manufacturer real advantages, hard to fix in dollars or pounds, but just as actual and valuable. The director of the largest printing office in the United States told me that he had tabulated results and studied them with great care with the conclusion that he obtained over 20 per cent. more work from a given set of operators and machines with the electric equipment than he had with the old countershaft method, and his experience has been the experience of many others controlling large establishments. This result is due largely to the ability to adjust each piece of apparatus readily to the most economical speed, both as to the machine itself and the operator.

The ability to control and regulate the operation of apparatus at a distance by simple push buttons or switches is another advantage. In one pumping system, pumps drawing from wells situated miles

apart are started and stopped from a central point by opening or closing switches, and in this instance a telephone is used to allow the operator to hear if pump is operating regularly.

Electricity in power transmission and application is as reliable as mechanical devices, the only part subject to trouble being the motor. With ordinary care and proper design, this piece of apparatus should wear indefinitely and not cause as many shut-downs as the breakage of belts.

The ease of measurement is especially valuable in buildings devoted to manufacturing purposes but occupied by separate users of power. In older buildings of this type, the method employed involved the use of a slow-speed steam engine belted to a vertical shaft, and this in turn belted to various countershafts on the different floors. The leases provided that the tenant was to be allowed 8, 20, or 50 horse power, as the case might be, and this horse power was estimated from the tenant's idea of what he would require. If the tenant's business increased, there was no satisfactory way of determining the increase of power supplied, as the variation in load from moment to moment in almost all cases made a definite determination of power impossible. Even if this power was determined fairly accurately for one day, by means of a transmission dynamometer and indicator cards, it was no criterion for the next day's use, or the use a month after.

Under the electric system, with a meter measuring accurately and registering the total quantity of power used, or more correctly the energy supplied, the tenant pays for what he receives, and the seller can make his charges more equitably to the different tenants. This also results in more economical apparatus and less waste in its employment. It is a fact shown in several examples that the quantity of electricity used without meter was two or three times that used after meters were installed. The protective feature is also important, as by means of circuit breakers and fuses stopping the flow of current automatically at a fixed amount, the limit of strain to a given piece of machinery may be fixed and serious damage through overload averted.

The use of electricity for lighting preceded its use for power, but its great development has been coincident with the increase in its use for power purposes. It has all the advantages of all other illuminants, and few of the disadvantages. In the form of incandescent lamps it replaces gas for localized lighting, and in the arc light we have the nearest approach to daylight so far obtainable—that is, a diffused and general illumination.

The use of electricity for heating is apparently uneconomical, as

is evident when it is remembered that rarely more than 5 or 6 per cent. of the heat energy in coal can be converted into electrical energy; but as gas has replaced coal for localized high-temperature purposes, electricity is in turn replacing gas. The reason for this is not entirely a question of comparative cost of the two supplies. In general, however, it is cheaper to heat by electricity than by gas, where electricity is supplied from a private plant for other purposes and the whole or part of the exhaust steam from the engine can be used. This has had a great deal to do with its introduction in large hat factories where great quantities of low-pressure steam are required for other purposes. Besides, it is not a case of comparing the cost of manufacturing gas with the cost of manufacturing electricity. The cost of manufacturing gas is but a small percentage of the selling price, and it is this price which is to be compared with the cost of adding a certain amount of electrical output to the previous output of the plant; that is to say, the cost of the additonal output is ordinarily limited to additional coal and additional fixed charges, labor, oil, waste, and other supplies remaining the same with or without electric heating. Frequently in small plants the electric heating serves merely to raise the average load of the engine during the day run, and the increase in coal required is not in proportion to the increase in energy supplied. Under these conditions, electricity may cost the manufacturer much less than gas. Where this is not the case, and the electricity for heating costs more, the reduction in fire risk, freedom from production of poisonous gas in the rooms, concentration of the heat, and its cleanliness, free from deposit of soot and similar objectionable attendants, render its use advisable.

Almost all the modern hat factories are equipped with heating apparatus for ironing, glue kettles, and dozens of special applications. Printing offices are using electric heating apparatus in a great variety of ways. Dental companies use it for their moulds. It is used for ruffling machines, ironing, pressing, and in fact is doing the work that gas did with more satisfactory results. In one instance where the energy is derived from a large water power, electricity is used to heat water and small rooms,

For usual temperatures the heat is obtained by causing a flow of electricity through small wires, the energy used in overcoming the resistance being transformed into heat.

Where a high rate of heat emission per square inch is desired, with results similar to those obtained from direct gas flames or Bunsen burners, low electric pressure (voltage) must be used so that the

resistance wires may be close together, the insulation light, and the amount of current for a given quantity of energy comparatively heavy.

Where a low rate of heat emission is needed, the voltage may be higher, but in no case should it exceed from 120 to 130 volts. It may be well to explain the reason why a lower voltage is desired:—a given quantity of energy, as for example, one kilowatt, requires 5 amperes at 200 volts, or 50 amperes at 20 volts. The loss of energy, that is to say the heat developed in passing through a given resistance, is equal to the square of the current (amperes) multiplied by the amount of resistance (ohms); hence in the instances just cited, if we wish to use up 1 kilowatt of energy and develop this quantity of heat, with 200 volts we would have to have a resistance of 40 ohms, and with 20 volts we would only need 2/5-ohm resistance. In order to get 40-ohms resistance a great quantity of fine wire, all of which would have to be insulated, would be required and this wire and insulation would be mechanically weak and the heating would not be evenly distributed on account of the necessity of superimposing several layers of wire. In the second case we would need a small quantity of heavy wire, the apparatus would be strong mechanically, and the heat could be uniformly distributed without difficulty.

Where very high temperatures are required, apparatus similar to an arc lamp is used, the heat being developed between the carbons forming the terminals of the arc and the arc enclosed in a suitable heat-resisting furnace. This is the process used in melting refractory metals, and by Moissan, in manufacturing small diamonds in his famous experiment.

The application of electricity to chemical and metallurgical processes is special work and has a field all its own. In these lines notable examples of the chemical and metallurgical uses are electro-plating, electric refinement of gold, the manufacture of sodium and carborundum, the fixation of nitrogen from air, and the removal of iron impurities.

The two main systems of distribution for the diverse purposes outlined are direct and alternating-current systems. In a paper written for THE ENGINEERING MAGAZINE in September 1901, the comparative value of these systems was discussed, as well as the best voltages to be used. Since the writing of this paper, the conditions have not changed materially, although the manufacture of alternating-current apparatus has been taken up by more large companies, the apparatus has become better standardized, and the development carried on to greater perfection; but the alternating-current apparatus is still more

expensive than that for direct current, without apparent reason except the greater competition existing in the direct-current work. In my opinion, the 125-volt, two-wire system is still the preferable one in most instances. Where electric heating with a high rate of heat emission requires a large proportion of the energy supplied, alternating current may be used to great advantage. With this type of current, transformers may be used to reduce the pressure and increase the current in direct proportion. This can also be done with direct current, by rotary transformers, but not in as convenient a way as with the alternating current. The other conditions under which the alternating-current system is advisable were fully covered in the paper mentioned above.

The question of speed variation of tools by change in speed of motors has been the subject of a great deal of work during the past few years, and the articles which appeared in the recent numbers of THE ENGINEERING MAGAZINE covered the field quite fully.* For ordinary cases other than direct-connected tools, the speed variation obtainable by variation of the field strength is sufficient and the two-wire system is advisable. Where a finely divided and adjustable speed control on large motors is wanted, multiple wiring with different pressures (voltages) between sets of wires is necessary, or some mechanical speed changer such as the cone pulley must be adopted.

In designing the equipment for a factory or manufacturing building, it is advisable that the electricity for lighting and the electricity for power shall be supplied from different mains controlled by different switches on the switchboard. The object of this division is to prevent flickering of the lights with variations in motor load. If lights are taken off the same line as supplies the motors, an increase in the demand on this line, will cause a drop in pressure on the line itself and hence cause a variation in the lights. There should be no drop in pressure at the dynamo terminals, as the engine governor will keep the engine speed sufficiently constant to prevent a change in electric pressure with increase or decrease in load; hence by taking the lighting connection at a point as near to the dynamo as possible—that is to say, the switchboard—trouble in the lighting due to variation in motor load is minimized.

Where factories are of fireproof construction, it is usual to run the wires concealed in iron conduits, but where the buildings are of ordinary mill construction, wires for lighting or small motors are

* The Development and Use of the Small Electric Motor, by Fred. M. Kimball; THE ENGINEERING MAGAZINE, April-July, 1903.

run exposed and supported on porcelain knobs or cleats spaced not more than 4 feet apart. It is advisable to sub-divide the motor circuits as much as possible without undue complication; this is particularly important where a constant speed is desired.

The mains to supply the motors, lights, and other apparatus are run from the switchboard, located in the engine room, to small switchboards at each floor, called panel boards, and from these circuits are run to the motors, circuits usually being terminated in the starting resistance, which may or may not have a switch mounted on its cover. The starting resistances should be equipped with protective devices to cut off the electricity in case of momentary overload sufficient to damage the motor, and with a similar device to cut off the electricity should the electric pressure be removed by the blowing of a fuse or other cause. The heavy leads to the motors are almost invariably run in iron pipe.

The choice of motors is one involving careful study of the requirements of the apparatus to be driven; the types differ as the work varies. Of direct-current motors there are four types; viz.:—the series, the shunt, the compound, and the differential. Of alternating-current motors there are the single-phase, two-phase, and multiphase (three or more phases), and these latter are in turn sub-divided into those starting with a throttling resistance connected to brushes, and those starting without throttling resistance, having no brushes. There are others known as the repulsion type and the series type, but these were designed for railway work and as yet are not in extended regular use. These motors of any type may be designed for any voltage, but the standard voltages for direct current are 80, 110-125, 220-250, and 500; for alternating current, 100, 200-220, 400-500, and 1,000.

The series direct-current motor is applicable to work requiring a speed varying inversely as the load and a large power for starting. Such a motor is usually employed for cranes, hoists, and street cars.

The shunt motor is used in the great majority of applications, and is suitable where it is desired to obtain a speed constant within 5 or 10 per cent. throughout a range from no-load to double full-load. The shunt motor has a strong starting power, but where especially strong starting ability is desired and constant speed is not essential, the compound motor is used, as this combines the features of the series and shunt machines; the more a motor is compounded, i. e., provided with a magnet winding through which the main current passes, the more closely it resembles the series motor. Elevator motors, heavy

punch and roll presses, large printing presses, mills for crushing and grinding, etc., are usually provided with this type of motor.

The differential type is more seldom used, and it is designed to obtain absolutely constant speed under varying conditions of load, or an increased speed with increase of load.

In the alternating-current types, the single-phase motor is handicapped by its inability to start under heavy load (unless equipped with special apparatus) or to carry excessive overloads. It has good electrical characteristics from the plant standpoint, as it is simple and has a high "power factor." Unless local conditions forbid, the alternating-current motor for factory work is the two- or three-phase type, and these have characteristics similar to the shunt-wound direct-current motor. The brush type is preferable for motors of large size where it is desirable, on account of the dynamos and lights or for other reasons, to keep the first inrush of current on starting down to a small amount. This type is not quite as simple as the brushless type, and for small motors (up to 10 horse power), it is rarely used. The brushless type is used for large sizes as well as small, and for shop work and dirty places where the flickering of lights is unimportant, and where the generator and transformer capacity is ample, this type is preferred.

Motors may be designed for any speed, but the lower the speed the higher the cost, as the capacity of a motor for a given size varies almost directly as the speed .

EDITORIAL COMMENT

THE whole trend of modern works management, on the physical side, is toward increase of output as a means of cost reduction. The fact kept constantly in view in running the power plant and the machinery is that fixed charges remain unchanged through a wide range of difference in volume of manufactures, and hence become proportionately small as that volume rises. If, for example, the cost of general management, rent, interest, taxes, insurance, lighting and heating, power, etc., amount to $50,000 a year for an output of 100 machines, each machine must bear a burden of $500 as its share of general expense, over and above the labor-and-material cost. If, however, the same plant can be speeded up to an output of 200 machines, this general-expense burden on each one drops to $250. It can be sold at the same price as before with $250 more direct profit to the maker, or it can be sold for $250 less with the same direct profit as before, and with a great indirect advantage in enlarging the possible market and in meeting competitors. Hence the strenuous and striking efforts to increase production by study of machine processes, the use of high-speed tools, electric driving, multiple setting tables, and all the other devices of the "modernizing engineer."

* * *

ALL this seems so obvious that the statement of the principle even is superfluous—until we turn from the physical to the human side of the manufacturing problem, and find there that the whole scheme of production is subject to constant, wasteful, and brutal interruption because of the inability of the two elements—employer and employees, motive power and moving parts—to work in any kind of harmony, or to adjust their differences by any means save the archaic one of coming to a complete standstill. The utmost refinements of skill are put upon the machinery, that minutes may be saved; the whole plant is shut down in idleness for weeks, while a strike or lockout drags itself to an often wholly inconclusive settlement. Meantime the public suffers perhaps all manner of inconvenience, and the idle time, with all its unused potentialities of productive effort, is wasted for ever. There is something wrong with the industrial philosophy which is so marvellously effective on the mechanical side and so complete a failure in dealing with the workman.

It would be foolish as well as futile to dream that these conditions can be suddenly bettered. No argument to the intellect can gain at once a controlling power over a vast body of men, sufficient to silence the promptings of impulse, the ingrained prejudice of class, or the demands of apparent immediate personal interest. It did not comfort the individual hand-weaver whose employer was installing machinery to know that the power loom, which he was too old to learn to run, would eventually employ a hundred of his class where formerly one had worked. All that he could see was his own prospect of immediate starvation. No economic argument about the ultimate

good of the race would feed his family, or deter him from the hopeless attempt to oppose fate by smashing the new machinery, if he could. And no demonstration of the economic basis of trade-unionism will be kindly received by the employer whose men have been led out in an unreasonable strike, or whose works have been fired by labor rioters. There is no panacea but common-sense, reason, and justice. Common-sense is unfortunately rare, and the world's most inspired moral teachers have been preaching reason and justice for several thousand years, without converting the hearts of more than a very small discipleship.

* * *

THERE are, however, certain truths so apparent that they ought to be tacitly accepted by both sides; and being so accepted, they should greatly widen the ground over which there should be permanent peace between capital and labor, and greatly temper also the bitterness of the struggle on outlying points.

Foremost is the fact that organized labor is an inevitable outgrowth of modern conditions of manufacturing. It is a primordial instinct for those who have common interests and dangers to make common cause—an instinct older than the swarming of the bees or the herding of the wild horses. And the factory system first facilitated the formation of the union by bringing the great company of workers together in the closest personal contact, next held up to them the example of successful organization in its corporate ownership and management, and finally supplied the imperative motive by accentuating the frequency, the suddenness, and the weight of those economic shocks to which the wage-worker—the least able to bear sudden deprivation of income—has unfortunately always been most exposed. The first trade-unionism was the only resort of workingmen who found themselves confronted with the conditions of the early "factory era," and like most expedients under desperate conditions, it was itself desperate. It was blindly selfish, because the model set for it was so. As it gained power, it was—or attempted to be—hideously and impossibly arbitrary, because employers had been arbitrary. If from the outset, employers, because they were stronger and farther-seeing, had felt it incumbent to shield their employees so far as possible from the shocks of economic changes, trade unions might have been conceived in a different spirit and might now have been giving their attention to wise and useful things, instead of the often senseless and exasperating wrangles in which they waste the energy and substance of their members and the world at large. But much of the present trouble comes from the fact that the selfishness of the early workmasters is recoiling upon the heads of the present generation. Secure in their wealth and influence, protected by the ability to insure their property, to mobilize their capital and divert it from decadent to prosperous lines, to control legislation and hedge themselves in with tariffs or bolster themselves with subsidies, they were indifferent to the plight of the laborer, naked to the storm of adverse conditions and changes. The worst examples of this indifference probably were furnished by the manufacturers of Lancashire and Yorkshire in the early nineteenth century—but are we in a position to condemn? Here are the words of Grover Cleveland, written in the White House in 1887:—

> "The discontent of the employed is due, in a large degree, to the grasping and heedless exactions of employers.
>
> "Those who toil for daily wages are beginning to understand that capital, though sometimes vaunting its importance and clamoring for the protection

and favor of the Government, is dull and sluggish until, touched by the magical hand of labor, it springs into activity. And the laboring man is thoughtfully inquiring whether, in these circumstances and considering the tribute he constantly pays into the public treasury as he supplies his daily wants, he receives his fair share of advantage. . . . The gulf between employers and employed is constantly widening, and classes are rapidly forming, one comprising the very rich and powerful, while in another are found the toiling poor. As we view the achievements of aggregated capital we discover the existence of Trusts, combinations, and monopolies, while the citizen is struggling far in the rear, or is trampled to death under an iron heel."

The unions can not be suppressed; but their false economic theories can and must be exploded, their false leaders retired, their false aims corrected, their false pretensions curbed. Some of these operations will be severe, and only to be administered by an organization of employers as strong, as coherent, as devoted to their cause as the rank and file of the labor unions, but far wiser in their purposes and absolutely just in their aims and acts. It is common to condemn the unionist for his unhesitating obedience to his cause; but it must be remembered that the attitude of most employers has been that of open warfare against the union, or at best an armed truce with it. The unionist feels himself an industrial soldier, constantly in face of the enemy—and is there anywhere a more complete surrender of personal liberty than in the case of the soldier, who takes the life of others, or lays down his own, at the command of his superior?

Enlightened unionism is no more necessarily selfish and arbitrary than enlightened corporate management. It rests largely with employers, who, whatever their failings, have had the courage and foresight to carry the factory system to triumphant economic success, to turn this union movement also to enlightened and profoundly useful ends. For it can no more be "smashed" than the use of machinery, or the whole system which developed from the use of machinery, could be smashed. Here and there a union may be broken, as here and there a factory was burned and its machinery destroyed; but the union will organize again, just as the factory was rebuilt. It is as logical, as reasonable, and as inevitable that labor should organize as that capital should organize, and those who seek to destroy the unions are as misguided friends to employers at large as the early labor leaders were to workingmen at large. Without the slightest sympathy for most of the demands put forth by union labor, or for most of the methods by which it seeks to reach its ends, but with the profoundest devotion to the cause of productive industry as represented by the manufacturer, we urge the recognition of union labor as a necessary development, and the concentration of effort upon its diversion into and confinement within its proper bounds.

* * *

THE solution, we believe most emphatically, will be found in the raising of the moral and intellectual tone of the unions by the entry of a better class of men—a sane, reasonable, and conservative element—so that, with labor represented by a tangible and responsible organization on the one side, and capital represented in like manner on the other, differences may be settled on a sound and equitable basis by conference, mutual explanation, and, if necessary, arbitration.

And this result will be secured, not by antagonizing the union, but by encouraging the better men to join it, and thus, by numbers and force of influence, retiring the demagogue and agitator into an impotent minority. It is

not the policy of Mr. Parry, but that of Mr. Mellen, which offers the hope of the future. The open shop—emphatically, yes! But open in the freest sense, and in the spirit defined by Mr. Mellen, quoted in our last number, and now repeated as giving, in our opinion, the definition of an ideal attitude for the employer. No manufacturer need hesitate to place himself upon the same platform with so large an employer of labor as the president of the New York, New Haven & Hartford Railroad:—

> "I am going to surprise you by saying that I regard the unions as a condition that has come to stay; that I have no prejudice whatever to properly-conducted ones, and express my wish that our men generally would join them, not that I would run a union plant as such, for I would not coerce my men nor consent to discriminations as between those who were and who were not members, but I would wish to have in the unions the conservative influence of many of the good men who are out, to counteract the floater, the anarchist, the man who has nothing at stake in the world, who works with his mouth more than his hands.
>
> "My advice to you who have families, who have a stake in the world, is to join your unions, and make yourselves felt in them. Be always a force for conservatism. It seems to me as much in your interest to do this as that you shall attend the caucus and nominate good men for office and vote for them at the polls. Your apathy is the opportunity of the demagogue, the anarchist, the floater, who has nothing to lose."

Unquestionably, there are cases and localities where drastic purgative treatment is needed before the unions are healthy enough to be received into any kind of industrial fellowship. But it is not impossible that the attitude of fixed opposition to organized labor heretofore generally maintained by employers has given the union its chief charm to a turbulent, lawless element always perversely disposed to be "against the government, whatever it is." The relaxing of that opposition on the part of employers may cause the union to gain quality by a double process—by making it more congenial to the conscientious workman who is naturally disposed to harmony with his employer, and by removing the attraction of opposition which now draws to it the agitator whose instinctive delight is in discord.

It is certain, at all events, that the present conditions hold more of menace to our national prosperity—even our national stability—than anything else within the political and economic horizon. On grounds of high expediency, therefore, as well as industrial economy, is it not well worth trying some radical modification of the policy under which these conditions have developed and under which there is no hopeful sign they can ever be ameliorated?

* * *

It is probably unnecessary to give serious attention to the frothings of certain Chicago papers, which have been demanding that all studies for the Panama Canal be taken up again *de novo*, so that a wholly "American" solution may be had. The years of supremely able and almost priceless study and investigation expended upon the work by the Nouvelle Compagnie —study of which the essential data and results have been summarized in these pages by General Abbot—these could not be replaced except by the expenditure of twenty-years time and untold millions of dollars by the American commission. And to be consistent, the Chicago movement should not stop there. This new Know-nothingism which would use only the domestic brand of research and investigation must reject much more than the conclusions of the Nouvelle Compagnie. It must throw overboard Bessemer, Stephenson, Watt, Newton, Copernicus —and what of Christopher Columbus? Shall Chicago accept anything discovered by one who was not an Ameri-

can? Never! Let the discovery be made over again, under Chicago auspices.

* * *

To the same order belong, it is to be hoped, the rumors that some members of the commission are favoring a sea-level plan with a dam at Gamboa and a tunnel to the Pacific. It is scarcely credible that engineers of standing should engage in futile consideration of a scheme which has neither novelty nor good sense to commend it. This project was one of the earliest to be considered by the engineers of the Compagnie, and one of the most promptly discarded on account of its manifest inexpedience. The sea-level canal at Panama is a possibility of the future, but of the future only. Any attempt at it now (or at any time by any tunnel scheme) would be wasteful to the point of disaster. The only really good solution will be found by following the general features of the project adopted by the Nouvelle Compagnie, perhaps as modified and adopted by the Isthmian Canal Commission. The former has been admirably supported by General Abbot, in several contributions to this Magazine, while the latter was advocated with equal vigor, in our issues for January and June, 1903, by the late George S. Morison, whose loss is more and more regretted as the importance his talent and force might play in the completion of the work become more apparent.

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BUT even in his most emphatic argument for the high-level plan, as distinguished from the low-level lock plan of which General Abbot is the leading advocate, Mr. Morison admitted that a second lake, retained behind a dam at Alhajuela, would be "the most economical and satisfactory method of storing the reserve water which will be required," to say nothing of its value in bettering the navigation of the canal by absolutely controlling the upper Chagres. Now it is suggested by one of the highest authorities in the United States that there would be enormous advantage to the work of building the canal if this dam were built *at first*, instead of as a supplementary undertaking. The Chagres River would thus be made, from the start, the most useful agency in the construction work. The great water power made available at the dam could be developed by turbines and electrically transmitted for use at any point along the line. It would particularly facilitate the transfer to the dumps of the spoil from the Culebra cut. And as the installation would be needed later for the operation of the canal, it would be money doubly well invested.

* * *

ALTHOUGH the work of the Panama Canal Commission has not yet appeared before the public in any very conspicuous manner, it is interesting to note that very important progress has been made in the fundamental operations upon which the success of the whole undertaking must rest. Probably no actual construction work will be begun before July of next year, but in the meantime plans for the sanitation of the entire zone have been formulated, and these are now being actively pushed. When it is understood that there are about two-thousand buildings of all sorts included in the property acquired from the French Company, as well as all the towns and villages along the route and within the canal zone, that all need to be overhauled, sterilized, and made healthful, and that a complete supply of pure water is to be provided along the route, it will be seen that there is plenty of work to be done before the actual excavation is started. For all this work the control and operation of the Panama Railroad becomes invaluable, and its possession greatly simplifies the work of the commission.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

WINDING PLANTS FOR GREAT DEPTHS.

PROBLEMS OF INERTIA, ACCELERATION, CONSTRUCTION AND OPERATION IN CONNECTION WITH DEEP MINING WORK

Hans C. Behr—Institution of Mining and Metallurgy.

ONE of the natural tendencies of the adoption of modern rapid methods of mining is seen in the rapid exhaustion of levels and veins of ore, so that it becomes constantly necessary to deepen existing mines to give access to fresh strata. Thus depths of nearly 5,000 feet have already been reached in several mines, and methods of operating at still greater depths, such as 6,000 to 8,000 feet below the surface will doubtless soon have to be considered.

For these reasons the paper of Mr. Hans C. Behr, presented before both the Institution of Mining and Metallurgy, in London, and the South African Association of Engineers, at Johannesburg, is of much importance, dealing as it does with the important problems connected with the hoisting of ore and materials from these great depths. The paper was discussed *in extenso*, both in London and at Johannesburg, and the whole forms practically a treatise in two portly volumes, rather than the ordinary example of a professional paper.

The principal question connected with deep mining lies in the construction and operation of the hoisting machinery, and the great problem to be solved in this matter is the management of the ropes. In lifting materials from a small depth the weight of the rope is insignificant in comparison with that of the load to be raised. When, however, the depth is increased the weight of the rope becomes proportionally greater, besides being a variable quantity, a great length and weight of rope forming the load when the cage or skip is at the bottom of the shaft, and this length and weight diminishing to nearly zero when the top of the shaft is reached. It is obvious, therefore, that with very deep shafts the use of a single lift, with rope of uniform diameter, wound upon a cylindrical drum, an arrangement answering very well for moderate lifts, will throw a very great and irregular load upon the winding engines.

The importance of considering the weight of the rope in deep mine hoists will be seen from the fact that modern wire ropes, with a breaking strength of 120 tons per square inch, have their safe load reached by the weight of the rope alone with a length of about 8,000 feet, taking a factor of safety of 7, so that at such a depth the entire strength of the rope would be required to sustain itself regardless of any useful load to be hoisted. If a factor of safety of 5 be permitted, the maximum length of rope is 11,400 feet, so that the possibilities in this direction may be seen to be very limited.

When the depth of the mine is entirely within the possibilities of single long hoists the feature to which much attention is devoted is the equalization of the load upon the winding engines. As has already been noted, the load due to the rope is continually varying, being a maximum when the cage is at the bottom, and diminishing as the top is approached. Various methods have been proposed and used to equalize this load. The most complete is the use of a tail rope; this making the load constant at all points, and equal to the maximum.

Another plan is to employ taper ropes, since there is much less load upon the lower part of the rope than on the upper portion. The variable load upon the engine may also be partially equalized by the use of conical winding drums, the radius, and hence the leverage changing according to the load, much in the manner in which the old chain and fusee movement was used in watches. The taper rope has the especial advantage that much of the weight of the rope is saved, since a rope of uniform diameter must necessarily be of the diameter sufficient to sustain the maximum load, and therefore much heavier than is needed at the lower end.

Mr. Behr examines all the operative conditions and derives mathematical formulas for practical use, giving also examples of the applications of these to specific cases. In general his conclusions were that for depths of 6,000 to 8,000 feet the hoisting should be done in two stages, preferably by two separate engines on the surface; single-stage winding being recommended only for depths of less than 4,500 feet. He emphasized the desirability of using taper ropes, and for this reason he did not advocate systems such as the Koepe or Whiting, in which the rope is passed a few times around a winding drum and then over an idler. These latter methods, when operated in connection with tail ropes, give very good results for depths within the convenient limits of cylindrical ropes, but their use prevents the employment of taper ropes. The winding engines with conical drums are considered the most advantageous, but Mr. Behr considers desirable even smaller end diameters than are now customary.

The general trend of the discussion naturally led to the consideration of the ropes. It is possible that improvements in materials may provide ropes of greater strength and less weight than are now available, but there must naturally be a limit in this direction, and the cost limit as well as the strength limit must be considered. The winding engines also came in for a share of the discussion, but the most interesting part of the matter lay in the remarks of a few of the more independent and less conservative men, who realized that the best prospect for advance must lie in the adoption of some other method of hoisting than that which makes the greater part of the load not only useless but troublesome. If the greater part of the power and expense in deep-mine hoisting comes from the ropes, the sooner the ropes are done away with the better. So far as the question of the transmission of power is concerned, the cable has long since been superseded by the electric conductor in other places, and for horizontal traction, in the case of tramways the nuisance of the cable has been most successfully abolished. Naturally vertical traction is a more difficult problem than horizontal, but it certainly appears that the difficulties to be overcome with vertical electric traction are fewer than those which are seen to exist with rope hoists and winding machinery.

The true solution of the problem of getting valuable material from great depths lies in the placing of the motive power upon the cage, and dispensing altogether with the hoisting rope. An electric motor could be used, as was suggested by Mr. Ashmore, to operate gearing meshing into vertical racks, exactly as the engines on rack mountain railways are worked. The difference between the mountain railway and such a hoist is mainly one of grade, the mine hoist usually having a grade of 100 per cent., or rather more than double that of the steepest mountain roads. Mr. Ashmore also suggests that the energy of the descending cage could be recovered electrically, and indeed the only immediate objection to this plan appears to be that it would be slow. It is by no means certain that a good speed might not be attained with such a system, especially if the details were worked out by engineers having experience with the possibilities of such machinery, and not hampered by the burden of mining precedents. It is certain that a much greater proportion of the energy supplied would be recovered in useful work, and the larger loads carried might make up in great measure for the slower speed of movement, so that the rate of delivery of material is the question to be considered rather than the linear speed.

The real question settles down to one of cost, and if the material to be raised is of sufficient value to warrant the expense of devising and constructing machinery to get it out we may be well assured that hoisting machinery will be forthcoming to operate at any depth at which men can be employed.

SMOKE PREVENTION.

CAUSES OF THE PRODUCTION OF SMOKE IN STEAM-BOILER FURNACES AND METHODS OF MINIMIZING THE SMOKE NUISANCE.

R. S. Hale—Mutual Boiler Insurance Company.

EVER since the introduction of steam power the smoke nuisance has been with us, and it is a matter of record that some of the most earnest work of James Watt was expended upon the invention of improvements in furnaces to prevent the production of smoke. Although many papers have been written upon the subject, by far the greater part of them have been prepared for the purpose of advocating, either openly or covertly, some special method of smoke prevention, and for this reason the admirable paper recently issued from the pen of Mr. R. S. Hale demands notice, since it is entirely free from any such motive.

Mr. Hale first examines the subject of mechanical stokers, and shows that from a study of a carefully selected set of tests, omitting any data which were in any way open to suspicion, it appears that there is little or no economy to be obtained from the use of mechanical firing. Stokers should therefore be considered upon their merits as devices for the prevention of smoke, and extravagant claims as to fuel economy from their use may be discounted.

The proper way to prevent the production of smoke is naturally to burn smokeless fuel. Anthracite coal makes no smoke, neither does coke, but these are not always to be had. New York, for example, is in the fortunate position of being able to employ anthracite for nearly all purposes, and when the supply of this fuel was interrupted, as during the recent coal strike, the difference in the appearance of the atmosphere was at once apparent.

"When hard coal or coke can be used the problem is solved. If soft coal which contains hydrocarbons must be used, it is impossible to prevent the smoke nuisance entirely. Soft coal, it is true, can be burned so as to give no visible smoke at the chimney-top, and it is likewise true that an oil lamp or gas jet can be burned so as to give no apparent smoke. Nevertheless, those who use electric light know how much cleaner their walls and ceilings remain than when they used gas or oil, while the discolored ceilings over a gas jet or oil lamp show where the soot comes from. I have had instances, in my practice, of serious complaint from soot in the neighborhood of a soft-coal furnace, though even the complainants admitted that practically no visible smoke came out of the chimney.

"This leads us to one very important consideration, and that is the fact that it is the actual quantity or weight of soot discharged into the air that causes trouble, while it is always the appearance of the chimney top that causes complaint. For instance, consider a furnace that gave dense black smoke for ten minutes each morning and each afternoon, or say twenty minutes in each twenty-four hours or 1/72 of the time. If we compare such a chimney with one that gave only 1/10 as much smoke at any particular moment but gave steadily some light smoke, the latter would cause much less verbal complaint to the smoke inspectors, especially under such ordinances as are now on the statute books, but would really be giving about six times as much soot.

"We may also compare a battery of boilers each with its own chimney as against the same boilers delivering into a common chimney. If a single one of these boilers smoked very badly and the others not at all, then with individual chimneys there would be much complaint, while with a single large chimney for the battery the top would show only a light smoke which would cause but slight complaint although the amount of soot would be the same.

"Another point that should be carefully considered, but that is not always considered, is the question of central power stations. The electric light and power companies are in large cities almost universally spoken of as the worst offenders against the smoke laws, but a brief consideration will show that we could afford to let them send forth almost any amount of smoke rather than put any serious burden on them. The choice whether a small fac-

tory or an office building shall put in its own plant to make its own light and power, or, on the other hand, buy electricity from the central station, is a close one, but the central station runs on a 2 pounds coal per horse power while the isolated plant seldom gets under 6 pounds per horse power. Hence, for the same amount of soot given forth into the atmosphere, the central station should be allowed to make three times as much smoke.

"Another point that is not often considered, in fact, that cannot be considered, is that the amount of soot is not proportional to the color of the smoke. A small chimney attached to a boiler that is using but a small excess of air may show a dense black smoke. Change this over to a large chimney and let a large amount of air into the flue at the base of the chimney. Then the color of the smoke at the top will be much lighter though the amount of soot may be the same as before."

The formation of smoke in the furnace, as Mr. Hale points out, is due to the dissociation, or "cracking" of certain of the hydrocarbon compounds formed during the distillation of the coal, the smoke not being one of the original constituents of the fuel, but formed by the separation of such compounds as paraffine into the lighter colorless hydrocarbon gases and the heavier sooty residue. To get rid of this soot requires the presence and intimate contact with oxygen at a sufficiently high temperature.

"If, while the temperature is high enough, enough oxygen is supplied and properly mixed with the hydrocarbon, the maximum amount of the hydrocarbons will be burned and the minimum amount of soot formed. Any failure to give the highest possible temperature, to give sufficient oxygen or to mix the hydrocarbons with the oxygen at this temperature will increase the soot. The harm done by *extra* oxygen may here be briefly referred to. If extra oxygen be supplied that does not burn, then the temperature of combustion and of the gases above the fire is seriously reduced. This immediately reduces the rate of transfer of heat from the gases to the heating surface, while, at the same time, the length of time that any particular pound of gas remains in contact with the heating surface is also reduced by the same serious amount, since a greater quantity of gas passes over the heating surface in the same time. The less time offered for transfer of heat and the lessened rate of transfer of heat, both operate to reduce the amount of heat taken up by the heating surface, so that the quantity of heat lost by the heat of the waste gases in the chimney is greatly increased. As this already is the most serious loss (amounting usually to two-thirds of the total waste of heat in making steam), any increase in its amount is a very serious matter."

In addition to the presence of the proper amount of oxygen and the maintenance of the proper temperature, the time element must be taken into account.

"The question of mixture of the air with the hydrocarbons is seen to be very important when we figure the time allowed. A rate of combustion of 20 pounds coal per square foot per hour is not unusual. This makes roughly about 20 pounds gas per pound coal, or 400 pounds gas. At ordinary temperature, say 60 F. or 500 absolute, this makes about 13 cubic feet per pound, while at combustion temperature of, say 2,000 C., this is about 100 feet per pound of gas, making a total of 40,000 cubic feet per square foot per hour, or 11 feet per second. In some forms of water-tube boiler the gases have but three feet or so of travel before they enter the tube nest, or the time for mixture and ignition is but 1/3 of a second. By providing a large combustion chamber, as may be done, for instance, in a horizontal tubular boiler, this length of time may easily be increased four times. It is impossible to do more than estimate this average time. In a horizontal tubular boiler, for instance, some of the gases undoubtedly travel the whole length of the boiler. Others travel only the vertical distance from the grates to the shell, but if they then deflect they may mix with other gases hot enough to keep up the temperature to the proper point and have a longer time for ignition."

Mr. Hale cites a case in which, with two batteries of boilers, otherwise identical, one set has the shell set two feet above the grates and the other four feet, with the result of a greatly lessened smoke production by the latter arrangement, doubtless

due to the increased combustion space.

"The advantages of a brick combustion chamber or brick arch in maintaining the temperature are very obvious. On the other hand, such construction, especially the arch construction, needs frequent repairs, and some designs of brick combustion chambers, such as checkerwork, check the draft and reduce the capacity and need frequent cleaning from ashes.

Another method of maintaining the temperature is the down-draft principle, whether in the Hawley type or in the underfeed stoker. These supply the coal where the fire is coolest instead of where the fire is hottest, and force the gases as distilled from coal when first heated to pass through the hot fire. The effect obviously must be good.

"The cost of these is high both for installation and repairs, and it must be remembered that the apparent cost of repairs is not the only cost. Repairs involve laying off the boiler, and the fixed charges such as interest and taxes all go on whether boiler is used or not; in addition to this the use of any apparatus subject to repairs involves keeping extra plant ready in case of accident that may happen unexpectedly to a minor part and cause the laying off of the boiler. Any such apparatus further requires more supervision on the part of the superintendent or manager. A much larger proportion of the time of the superintendent will be found to be devoted to the power plant when any special apparatus is employed."

All of the above methods are considered by Mr. Hale as tending to reduce the production of smoke, although he admits that complete prevention is impracticable.

"Short of the use of hard coal or coke, smoke cannot be entirely prevented. In a manufacturing district dependent upon the production of cheap power for its very existence, it is probably unwise to put any limit on the production of smoke. Any such restriction will increase the costs of manufacturing, and the reformers, while they may reduce the smoke nuisance, will find they have checked the development of the very basis of existence of the town.

"In districts partly residential, partly manufacturing, it is a question of judgment. Some restriction on smoke production is probably wise. Complete restriction is undoubtedly unwise unless it is practicable to force the use of hard coal."

THE SURFACE HARDENING OF STEEL.

A STUDY OF THE PROCESSES OF CEMENTATION AS APPLIED TO CARBON STEEL AND TO SPECIAL STEELS.

Léon Guillet—Société des Ingénieurs Civils de France.

THE process of cementation is one of the oldest in the metallurgy of iron and steel, since the original method of producing steel was that of heating iron in contact with carbon until a partial combination took place, the product being afterwards made homogeneous by remelting in crucibles. The ordinary operation of case-hardening is also a cementation process, and this, in various modified forms, is yet most important, being employed alike for the improvement of the small parts of modern automobiles, and equally for the perfection of the massive pieces of armor plate of the latest types.

In a paper recently communicated to the Société des Ingénieurs Civils de France, by M. Léon Guillet, the manner in which the operation of cementation, or surface carbonizing of steel, is effected is discussed at length, making use of the methods of metallography, or the miscroscopic study of the structure of the metal under various conditions.

Until recently the operation of cementation was one concerning which but little was known, from a scientific point of view, nearly all the practical work being performed according to empirical methods, acquired by experience, and often jealously guarded as valuable trade secrets. M. Guillet has shown that the process is one entirely capable of reduction to scientific and rational system, and examines its details in a most interesting and valuable manner.

The object of cementation is the production of a piece which shall be tough and resistent in the interior, while the exterior

surface is given a certain degree of hardness, suitable to stand wear or abrasion, and capable of receiving a finish possessing a low coefficient of friction. In order to produce this result the article is made of mild steel and then surrounded with carbon and subjected to a temperature sufficiently high to cause the carbon to dissolve in the iron. This gives a piece with a surface rich in carbon, while the interior remains unchanged, and a subsequent tempering permits the production of a surface of any degree of hardness desired. It thus appears that the operation of cementation is really one of dissolving carbon in a solvent of iron or mild steel.

This operation appears to be a very simple one, but investigations in the light of modern theories show it to be really very complex. Osmond has shown that iron can dissolve carbon only when the former is in what is called the *gamma* state, and that iron in either the *alpha* or *beta* states is incapable of dissolving carbon. For this reason it is necessary that the iron should be raised to a temperature of 800° C. before the operation of cementation begins. If the operation is conducted at the temperature at which the change from the *beta* to the *gamma* state begins there will be formed simply a layer of cementite, without any true solution of the carbon in the iron. The extent of the solution also depends upon the amount of carbon already contained in the steel, as well as the nature of the carbonizing material employed. In general, there are four factors to be considered in the operation: The nature of the steel; the nature of the cementing material; the temperature at which the operation is conducted, and the time during which the contact is maintained. It has been maintained by some that there are steels which are incapable of cementation, but M. Guillet maintains that this is incorrect so far as carbon steels are concerned, although it is true for certain special alloy steels.

By employing the methods of microscopic metallography M. Guillet has made some valuable studies as to the influence of variations in temperature, time, and material upon the effects produced, including the depth of the carbonizing, the time required for penetration, and the distribution of the carbon. These results are best exhibited to the eye by photography, and a number of microphotographs are reproduced in the original paper. In general it appears that there is no variation in the time required for the penetration for steels having an original carbon content of 0.51 per cent. or less, while for steels of higher carbon content rather discordant results were obtained. The time of penetration seems to depend upon the temperature, this appearing very clearly in the photographs. The influence of the cementing material is also to be considered, but it is impossible to lay down any precise points in that respect, owing to the wide variation in materials, and it becomes necessary to determine the action of each substance by experiment.

In general the cementing materials may be divided into three classes: those acting by the formation of carbonic oxide; those acting by means of a cyanide; and those employing hydrocarbons. Experiments made with pure carbon in a vacuum have demonstrated that no cementing action takes place; it is necessary that air be present and that carbonic oxide is formed. In the case of the cyanides there is a decomposition in which the carbon is liberated to be dissolved in the steel, while when hydrocarbons are employed, in the form of illuminating gas, petroleum vapor, etc., the carbon is released by dissociation. In general M. Guillet gives rules to be employed in practical operations. Steel of 100 to 150 carbon should be used. The cementing material should have a definite chemical composition, such as a mixture of 60 parts of carbon and 40 parts barium carbonate. The operation should be conducted at a temperature of 800° to 850° C., the temperature being maintained as nearly uniform as possible. It is desirable that there should be sufficient cementing material at all points around the piece, and a thickness of at least 5 centimetres of the carbonizing cement should be provided. The cemented piece should be allowed to cool and then placed in a furnace having a temperature of about 800° C., and allowed to become uniformly heated, after which it should be quenched.

M. Guillet illustrates a number of designs for furnaces to be used for cementing work, and discusses various practical points, in connection with the regulation of temperature, handling of material, and other details.

The cementation of special alloy-steels is also discussed in the paper of M. Guillet, but the extent of this field renders it impossible to do more than touch upon it. The best results have been attained with a nickel steel, containing about 2 per cent. of nickel and 0.20 carbon. Such a steel is much more readily cemented than an ordinary carbon steel, and it should be quenched at a lower temperature, about 750° C. Data are also given concerning experiments with manganese, chrome, tungsten, and molybdenum steel, but further investigations with these are desirable.

The paper of M. Guillet, of which we have been able to give here but a brief abstract, is a most important contribution to the subject of workshop metallurgy, and it shows conclusively the manner in which rational and scientific methods may well replace the older empirical manner of conducting such important operations.

APPRAISALS OF COAL LANDS.

APPLICATIONS OF SCIENTIFIC PRINCIPLES TO THE DETERMINATION OF THE VALUE OF MINERAL PROPERTIES.

H. M. Chance—American Institute of Mining Engineers.

ONE of the ways in which the work of the engineer is becoming of growing importance in the commercial world is found in the manner in which he is called upon to determine the real values of things. The financier may be an adept at the effecting of combinations, and capitalizing existing values at figures based upon the trade conditions involved, but he must know something about the real value of the thing he is handling, and for this information he is learning to turn to the engineer. An excellent example of this department of engineering is seen in the paper of Mr. H. M. Chance, presented before the American Institute of Mining Engineers, upon the subject of the appraisal of the value of mineral land, with especial reference to coal lands. In introducing the subject Mr. Chance refers to this phase of the matter.

"In no field of productive industry have the economic results attainable by consolidation been more clearly shown than in the mining regions of the United States. In many important mining centers unification of ownership of the most valuable properties has already partially or completely been attained, and in other districts projected absorptions and consolidations await only favorable financial conditions for their consummation. The iron-ore districts of the Lake Superior region, the coal-mines of Colorado, of Wyoming and of Utah, the anthracite mines of Pennsylvania, the Connellsville coking-coal mines, and large areas of bituminous coal-land in Pennsylvania, in Ohio, in the Indian Territory and in other portions of the United States, are now largely controlled by a few corporations operating on a large scale, or by a number of corporations working in harmony because of an affiliation and interleaving of interests.

"The tact of keen financiers and the diplomacy of men of great administrative ability are the chief operative forces in conceiving and accomplishing such consolidations, but in formulating and maturing them, the services of the mining engineer are often required to supply the facts upon which they must be based. For this purpose the expert is expected to furnish full and complete reports covering the quantity of ore, coal or other mineral available, its value per ton, cost of mining and treatment, etc."

It is evident that this kind of work requiries something more than a knowledge of the mere mining questions involved, since it includes also a familiarity with the economic conditions affecting the cost of production and transportation, the element of competition, and the market possibilities, broadening the work of the engineer into that of the man of business affairs.

The older methods of estimating the value of mineral lands were based upon the values which had been expended upon it, or upon the prices realized by other sales in the vicinity, but these are recognized as of limited usefulness. A more scientific method, used by Mr. Joseph S. Harris, has also been employed.

"By this method the total workable coal in the ground is first determined, and valued

at a certain sum per ton, this estimate being based either upon what the coal would produce if leased upon a royalty, or upon the profits of mining it. Using as a basis the rate of increase in production, as shown by past experience, the probable yearly increase of output is calculated, and from these figures the probable revenue is calculated for each year of the period during which the assumed output can be maintained, or until all the coal is mined. Then the probable future earnings of the land, either by royalty or through operation, are capitalized at their present money value, by the usual formulas for deferred payments, at a certain assumed rate of discount."

Other methods include the assumption of the operation of the property at a certain yearly output for a fixed number of years, or of the use of the actual net earnings as a basis, limited by the appraised value of the land, plant and improvements, as reached by other methods.

"While it is unwise to appraise at a high valuation the good-will of a purely commercial business, the value of a manufacturing industry producing staple products includes, as one of its most important factors, the established reputation of its products, its facilities for selling and distributing its output and the conections and friendly affiliations with consumers, dealers and transporting agencies that enable it successfully to retain its grasp upon the trade, to extend its operations and to expand and enlarge its business. In other words, an industry of this character can only be valued at its true worth by taking as a whole its property, plant, improvements, reputation of its products, its established trade, selling facilities and connections. Proper investigation having shown that the output of the concerns can be maintained for a long period, even at a rate of production in excess of present shipments, its value as a business proposition may be safely appraised, and in so doing it is customary to assume that the business, including plant and property, is reasonably worth a sum upon which the yearly net earnings will pay a satisfactory return.

"In order to confirm the valuation determined by this method, separate appraisals in detail should be made showing the value of the lands, plant and improvements."

Taking up in detail the valuation of coal lands, Mr. Chance shows that the engineer should familiarize himself with the quality and quantity of coal available, the thickness of the workable beds, the cost of mining and transportation, the mining conditions presented by the district, the character of the improvements required, and other conditions affecting the industry as a whole in the region under consideration. Some of the points naturally suggest themselves, but all are important.

The quality and quantity of the coal form the basis of the whole investigation, since these cover saleable material from which revenue is to be gained. The other points are mainly concerned with the charges against this productive element. Thus the cost of mining should be considered in comparison with the average in the district in which the property is located, while transportation forms a most important element in determining market values.

Mr. Chance plainly remarks that coal land so located that it cannot be reached by railroad at reasonable cost, or owned by persons not commanding sufficient capital or influence to secure the building of a railroad, is of small value.

The question of ownership is of much importance, and a mere change of ownership may affect the value in either direction very materially.

"If the coal is owned by those able to mine it quickly, the value is greater; if it is to remain untouched for a long period, or to be worked on a small scale, the value is less. The concentration of large holdings into one corporation increases the value of the whole as a unit to a sum far greater than the sum of the values of the individual tracts, because a corporation can establish selling-agencies at all important distributing and consuming centers; can spend large sums for advertising; can form close affiliations with manufacturing and transportation companies; can retain able counsel and employ the best managers and representatives that can be found; can own its cars and can make whatever outlay may be necessary to build up a large and permanent business."

Mining conditions, which naturally belong specifically in the domain of the engineer, are classified as belonging to the actual cost

of working; the possibility of planning large development with improvements of permanent nature; of output possible from each operation; and upon the capital required for the plant and its development.

In general the valuation of a mining property should be based upon the logical method of taking all the technical and commercial conditions into account and summing these up in proportion to their weight in the special case under consideration. No close rules can be given, but Mr. Chance has laid out the general principles in such a systematic manner that they can be applied to almost any case which can appear in practice, thus removing the work from the domain of guesswork and placing it in the category of scientific investigation.

HIGH-PRESSURE CENTRIFUGAL PUMPS.

APPLICATIONS OF HIGH ROTATIVE SPEEDS AND SERIES-CONNECTION TO THE CENTRIFUGAL PRINCIPLE FOR PUMPING.

Messrs. K. Sosnowski, Julius Divis, and H. Dubbel.

CENTRIFUGAL pumps have been employed for many years, and for the elevation of large volumes of water to moderate heights they have been found most satisfactory. The freedom from shock, the absence of valves or reciprocating parts, and the simplicity of construction have rendered the centrifugal principle a very useful one for moving liquids. It has been recognized for a number of years that an increase of rotative speed would enable centrifugal pumps to deliver liquids at greater elevations than is customary with such machines, and the principle of operating several centrifugal discs in series, each delivering the water to the next has also been found a practical method of increasing the height against which such pumps could be worked. These methods have been brought into practical service of late, mainly because of the rapid introduction of motors of higher rotative speeds. Electric motors may be designed to run at high speeds very effectively, while the development of the steam turbine has exerted a material influence in drawing attention to machines capable of direct connection to them.

Several articles have appeared discussing this development of the centrifugal pump, and among them we note a paper presented before the *Société des Ingénieurs Civils de France* by M. Sosnowski, and one in the *Zeitschrift des Vereins Deutscher Ingenieure* by Herr H. Dubbel, while the application of such machines to mining operations is treated by Inspector Julius Divis in the *Oesterreichische Zeitschrift für Berg und Hüttenwesen*, from all of which papers we make some abstracts.

The De Laval steam turbine is one of the best known machines of this type, and since it employs but a single steam wheel it necessarily operates at such a high rotative speed that it is obliged to use gearing to reduce the rotations to a number which can be employed in practical engineering work. Ordinarily the De Laval steam turbine is run at speeds of 20,000 to 30,000 revolutions per minute, being fitted with a reduction gearing of 10 to 1, to enable it to be connected to other machines. It has now been found practicable to utilize the direct speed of the De Laval wheel for the driving of a cetrifugal pump, with the result of increasing very greatly the head against which the pump can deliver water. Thus the ordinary type of centrifugal pump can operate against a head of 15 to 30 metres, but it has been found possible to connect a pump disc directly with the shaft of a De Laval turbine, running at 20,000 revolutions per minute and delivering 1,000 litres of water per minute against a head of 150 metres.

A pump wheel proportioned to be operated at such high rotative speeds is necessarily small in diameter and not adapted for the suction of the water. For this reason a combination has been made, using two centrifugal-pump discs, in connection with the usual arrangement of De Laval turbine. One pump disc is connected directly with the turbine shaft, while the other is driven from a second shaft geared at a lower speed. The slower pump draws the water from the lower level and delivers it to the high-pressure disc, and in this manner a very useful and effective combination is made.

In running several centrifugal pumps in

series it is not necessary that they should be operated at different speeds, and the usual plan is to place several discs upon one shaft and have each pump feed the water to the next. In this way a cumulative effect is obtained, enabling high heads to be overcome. Such an arrangement is especially applicable to electric driving, and pumps of this kind are now made by a number of manufacturers. Among these we may note an arrangement by Messrs. Sulzer Brothers, the well-known steam engine builders of Winterthur, in Switzerland. By placing the pumps on a vertical axis, and putting an electric motor on the same vertical shaft, a very compact arrangement is obtained for use for shaft sinking operations in mining. The whole system may be hung in a chain sling and lowered as the work progresses, occupying a minimum of space in the shaft and delivering the water direct to the surface. Such an arrangement has been used in a satisfactory manner against a head of more than 500 metres, showing a total efficiency of 58 per cent.

Another arrangement of multiple centrifugal pumps is that of Jaeger, constructed by several German builders. This pump consists of a series of centrifugal pumps on a single shaft, the pumps being provided with guide vanes, so that they practically form reversed turbines, and giving an excellent example of the reversibility of the hydraulic turbine, to which reference was made last month in these columns.

Among the pioneers in the construction of multiple high-pressure centrifugal pumps may be named Professor Rateau, well known for his work in the development of the steam turbine and of turbo-machines in general. He has been especially successful in the design of combination steam turbine and centrifugal pumping sets for mining service, and one of his machines of 500 horse power is in service at the Bruay mines, delivering 250 cubic metres of water per hour against a head of 350 metres, while others are at work in South America.

The development of the high-pressure centrifugal pump is especially interesting as a pendant to the growth of the use of the steam turbine, and attention is naturally directed to the general tendency in engineering work to get away from the difficulties which are involved in intermittent and reciprocating machines. It has been remarked that the form of steam engine which has, until recently, been generally employed, consisting of a piston having a reciprocating motion in a cylinder, had its origin in the fact that the first steam engines were employed to drive pumps for draining mines. When, later on, it was found desirable to use the steam engine to drive general machinery, the reciprocating engine had a crank attached to it, and thus, indirectly, a rotary motion was obtained. Now the problem is reversed. Having at length become released from the trammels and difficulties of the reciprocating engine by the improvement of the steam turbine, we find the centrifugal pump itself improved to be made suitable for the new conditions, so that the engine determines the character of the pump, just as another type of pump formerly controlled the lines along which the steam engine was at first developed.

THE RECOVERY OF TIN SCRAP.

ELECTROLYTIC METHODS OF TREATING TIN SCRAP FOR THE SEPARATION OF THE METAL FROM THE SHEET IRON.

The Engineer.

ONE of the principal uses to which tin is applied in the arts is for the coating of sheets of iron, these plates being subsequently used for the manufacture of various kinds of utensils and for roofing, and similar purposes. There is thus produced a large quantity of scrap, this including cuttings of the coated metal, and the discarded cans and other old articles of all sorts. The question of the recovery of the valuable tin from this waste has been attempted in various ways. In some cases the articles have been first heated, to separate the solder, and then cast into the cupola with other inferior iron scrap and run into sash weights and other articles in which quality of material is unimportant. The presence of the tin in the product rendered

it unsuitable for any structural purposes, and the value of the material thus obtained scarcely paid for the cost of its production.

With the development of electrical methods for various metallurgical processes it has been made evident that the separation of the tin from the iron might be commercially effected, so that both metals would be available for new purposes, and in a recent issue of *The Engineer* some account is given of the methods which have been devised for this purpose.

According to recently published reports, Germany possesses eight factories operating such processes, and these treat annually in this way about 30,000 tons of tin scrap. The average amount of tin in such material is only about 3.5 per cent., so that this corresponds to about 1,000 tons of tin, while the iron being free from alloy is also available for general purposes.

It is not difficult to see how electrolytic methods might be employed for the separation of tin from iron, but the small proportion of the more valuable metal in the material renders it imperative that the process should be an inexpensive one, and it is upon this point that many of the methods suggested have failed.

Details of a number of patents are given in the article referred to, but these may be broadly divided into two classes. In the first the tin is dissolved in an acid solution, either hydrochloric or sulphuric acid, or both, being used. The tin is then deposited by action of the electric current, while the iron is left in the solution and separated as sulphate of chloride. These processes have accomplished the desired result, so far as the separation is concerned, but the cost has proved too great to give commercial success.

The second class includes methods using alkaline solutions, the tin scrap forming the anode, and the solution being effected by the action of the electric current. Such a method is used by Goldschmidt, at Essen, the electrolyte being sodium hydrate, and the tin scrap, contained in iron baskets, forming the anode. This plant appears to be commercially successful, and is reported to be treating 50 tons of scrap per day. Several other plants are reported to be working in Germany, France and Russia, and there is little doubt that with proper attention to details and operative economies the electrolytic process may be made a working success.

"The cost of the electrical energy required to deposit tin from the sodium stannate solution obtained when tin scrap is employed as anode in a bath of sodium hydrate, is comparatively of little account when one bears in mind the value of the recovered tin. Thus a current of 10 amperes at 1½ volts will deposit 11.12 grammes of tin per hour from a sodium stannate solution at 70° C. with tin anodes; and 1 k.-w.-hour will, therefore, yield 733 grammes of tin at the cathode.

"Taking an average energy efficiency for the alkaline recovery process of 60 per cent., we find that 1 k.-w.-hour will yield 440 grammes tin, or that 2,500 k.-w.-hours will be required to yield 1,000 kilogs. (1 metric ton) of pure tin. Assuming the cost of power to be 1d. per k.-w.-hour, the cost of electrical energy per ton of recovered tin is found to be only £10 8s., or less than 9 per cent. of the present market value of the metal.

"The sodium hydrate employed as electrolyte can be used for a lengthened period before the accumulation of impurities in it necessitates its renewal, and therefore the actual running costs of the alkaline electrolytic tin recovery process are remarkably low. The difficulties of the process arise chiefly in connection with the working up of the deposited tin. This deposit is spongy in character, and is therefore troublesome to deal with, in the after melting operations necessary in order to obtain the tin in ingot form. No details have been allowed to leak out concerning the methods used, but it would seem probable that the spongy tin is first subjected to mechanical pressure, and is then melted in the presence of some inert gas or in a vacuum. Some loss of tin in the form of oxide or dross is likely to occur in the process. However, even when allowing 10 per cent. for the losses incurred while obtaining the deposited tin in ingot form, the alkaline electrolytic tin recovery processes ought still to yield a handsome profit, when the cuttings and scrap are obtained at a reasonable cost for collection and carriage, and when a market can be found in the locality for the remaining iron. The acid tin-recovery processes are less favorably situated as regards running costs, for

the acid is not renewed, as in the case of caustic soda, but is used up in dissolving the iron, and the saturated solution of ferrous-sulphate or chloride ultimately obtained is not likely to prove a very valuable by-product. Since tin scrap contains on the average only 3.5 per cent. tin and 96.5 per cent. iron, much more ferrous-sulphate than metallic tin is produced by the acid process. Assuming that only 50 per cent. of the iron is dissolved by the acid for each ton of metallic tin recovered, at least 29 tons of scrap will require to be worked up, and 70 tons of crystalline ferrous-sulphate will be produced per ton of recovered tin.

"The market for ferrous salts is, however, limited, and this fact explains the failure of many of the acid tin recovery processes which have received industrial trial.

"The alkaline electrolytic process for recovery of tin from scrap and cuttings is one which is likely to expand into an industry of considerable importance. In most large cities the collection and sorting of the refuse and garbage will in time be carried on under municipal control; and as the use of tin cans for foods is now so general, the amount of tin that could be obtained annually from the rubbish and garbage of our modern cities is much larger than is yet realised. The present methods of collection and despatch of this tin scrap to the German and other foreign recovery works are, however, costly, and it seems probable that the line of future development will be in the direction of tin scrap recovery plants worked as an adjunct of all large municipal electric supply stations. These plants would help to provide the electrical engineer with a day load for his plant, and would only require a chemist and a few labourers for their operation and control.

"Since the plant would draw only upon the local supply of tin scrap and cuttings, the charge for collection and cartage would be low; and a tin scrap recovery plant working under such conditions would be more likely to yield a profit than under the present arrangements in this industry."

THE PROPERTIES OF ALLOY STEELS

THE CONSTITUTION, BEHAVIOUR, AND APPLICATIONS OF STEELS CONTAINING METALS OTHER THAN IRON.

William Metcalf—American Society for Testing Materials.

SINCE the American branch of the International Society for Testing Materials formed itself into an independent organization there has been some cause for surprise that the word "testing" was retained in the name, as nearly all the papers and discussions at its meetings have related to almost anything but the unification of methods of testing materials. Apart from efforts at the framing of specifications, however, there have been presented before the Society various papers upon the general properties of different materials of construction and consumption, and among those at the recent meeting we note one upon alloy steels, by the veteran steel maker, Mr. William Metcalf.

Mr. Metcalf calls attention to the fact that the recognized varieties of carbon steel may be divided into three classes: crucible, Bessemer, and open-hearth steel, and that all three of these contain small quantities of other substances than iron and carbon. Thus phosphorus, sulphur, silicon, and manganese are found, as well as copper and arsenic, but these appear as the remains of impurities rather than as useful ingredients, altogether different from substances deliberately added with the intention of producing certain effects.

"From time to time we have put upon the market silicon steel, phosphorus steel, chrome steel, aluminum steel, none of which have won any permanent place in commerce. Of permanent alloy steels, we have nickel steel, manganese steel, self-hardening or air hardening steel, and the latest, the new variety called high-speed steel.

Nickel steel, containing comparatively small percentages of nickel, is used chiefly for structural purposes, giving increased strength and toughness. It has been applied mostly to armor plates and gun parts,

and lately it is being tested largely in rails to determine whether the increase in durability in difficult places will justify the greater cost over ordinary Bessemer or open-hearth rails.

"Hadfield's manganese steel is unique. Hard, tough, non-magnetic, non-hardening by quenching, non-annealable by any known method, practically unmachineable; it stands by itself, there is nothing to compare it to nor to test it by. It is finding large use for a number of special purposes.

"Self-hardening or air-hardening steel derives its name from the fact that when it is heated to an orange color and allowed to cool slowly in the air it becomes exceedingly hard. Some years ago it was known generally as Mushet steel, from the fact that its first development was due to the distinguished metallurgist whose name it bore. The usual composition of this steel is about 2 to 3 per cent. manganese, 4 to 6 per cent. tungsten, and carbon high."

From the Mushet steel to the modern high-speed steels now appears to be a natural step, although it was a long time before it was taken, and Mr. Metcalf shows an almost amusing unwillingness to believe that the step was taken by design. According to his view of the case some anonymous individual at the Bethlehem Steel Works may have blundered upon the fact that a tool of air-hardening steel was overheated, according to accepted notions, and that it was then accidentally found to be vastly improved. From such a chapter of accidents "the Taylor-White process was developed." There may be some who believe that there was more of accident than design in the work of a trained engineer and a skilled chemist, but such assumptions appear to be unnecessary. However, Mr. Metcalf accepts the results, and subsequently acknowledges that the older men are "standing on their heads once more" and that there has been a revolution in the art of making and using cutting tools of the metal he has spent all his life in making and studying.

After the first surprise, mingled with a dash of incredulity concerning the performances of the new high-speed steels, the matter began to receive general attention in all industrial countries.

"The potentialities were so great that nearly all of the leading steel makers in the work attacked the problem, with the result that the present high-speed steels are in no sense of the word air hardening. Manganese has been reduced from 3 to 4 per cent. to 0.30 per cent. to traces; tungsten has been increased to 10 to 20 per cent., instead of the usual 4 to 6 per cent., and the carbon is generally less than 1 per cent.

"There are about 50 different brands on the market, and of course each one is the best. Perhaps the analyses of two of the leading brands will be interesting, as follows:

	Per cent.	Per cent.
Tungsten	9.99	18.48
Chrome	2.83	2.90
Carbon	0.69	0.78
Phosphorus	0.010	Not determined
Sulphur	0.010	Not determined
Silicon	Trace	Not determined
Manganese	Trace	0.33

Another contains the following:

	Per cent.
Molybdenum	9.65
Chromium	....
Carbon	0.66
Phosphorus	0.016
Silicon	0.046
Manganese	0.22

"In one sense it is chaos. All traditions as to heating are completely reversed, and no one really knows what is the best. One brand is famous for its excellence in one kind of work, another in another kind, no one yet seeming to cover all of the ground.

"One thing is certain, the machine business is revolutionized. These tools have crowded ordinary lathes, planers, drills, etc., away beyond their capacity; machine builders are remodeling their machines to meet the new conditions, and many of the users are throwing out their old machinery for the new, or else remodeling and strengthening what they have."

Although the introduction of the new steels has caused many changes in machining operations, Mr. Metcalf thinks that the steel maker has the most to learn.

"He must find out why there is such a great difference in the work the steel will do, when there is so little difference in composition. He must find the composition or mixture that will come nearest to meeting

all the requirements. He has at his command now ferromanganese, ferrosilicon, ferrochromium, ferrotungsten, ferromolydenum, ferrovanadium and ferrotitanium. These alloys are all expensive, except the first two, costing from 60 cents to $12 a pound; therefore the present prices of high-speed steel, which to some people seem to be of the fancy order, are really not excessive.

"The successful production of the above named alloys marks a great advance in metallurgy, and, now that a demand has sprung up, it is certin that the supply will follow, with certainty and uniformity of composition and reductions of cost.

"The making and the utilizing of steel containing practically only carbon and iron, with some modifications made by the use of small quantities of manganese, silicon, tungsten and nickel, have occupied the best minds in the manufacturing and engineering world for many years. The last half of the nineteenth century saw most wonderful developments produced by the inventions of Bessemer and Siemens, aided by the skill and energy of the brightest engineering minds. At the close of the century it was customary to 'point with pride,' and to assume that so much had been done and so much was known that there was no room for more revolutionary changes, and the coming generation had only to tag along, utilizing these great advances with ease and comfort to themselves and with blessings upon their predecessors."

That this idea was fallacious is now altogether apparent, and the experience of the tool steel maker may well indicate to men in all other departments of work that the field for improvement is always open.

PROTECTION AGAINST EXPOSURE FIRES.

EFFECTIVENESS OF VARIOUS FORMS OF SHUTTERS, WINDOWS AND SCREENS FOR PROTECTION AGAINST EXTERNAL FIRES.

John R. Freeman—Engineering News.

WE reviewed in these columns several months ago the extent to which the buildings of modern fireproof construction had succeeded in resisting the conflagration at Baltimore, and to these we now add some comments upon the valuable address of Mr. John Freeman, before the National Board of Fire Underwriters, and published in *Engineering News*. Mr. Freeman had the opportunity of inspecting the ruins at Baltimore promptly after the fire, and his trained observation at that time has enabled a number of important facts to be secured for subsequent use.

It is generally admitted that the principal defect in the modern buildings, as revealed at Baltimore, is weakness against attacks from fire without. It has been too freely assumed that if a building is so constructed that a fire starting at any point in the interior cannot spread the main result has been accomplished. As a matter of fact nearly every large building has dangerous neighbors, and it has been shown more than once that the vulnerable part of the modern business building is to be found in the opening which permits fire to enter.

A most important protection for windows liable to exposure to external fire is a proper fire shutter. The standard fire shutter at the present time is made of wood, covered with tin, such a construction being generally assumed to be better than a sheet-iron shutter. Mr. Freeman tells the story of the origin of this idea, it being due to the fact that about twenty-five years ago, in a fire in the Pacific Mills at Lawrence, Mass., a tin-covered wooden shutter stood the fire while one of sheet iron warped and allowed the flames to pass around the edges. This case showed that the defect of the iron shutter was its liability to warp, but the reason for warping may be discovered, and in most instances removed by proper construction. The cause of warping is found in unequal expansion, or in the cramping of the shutter so that it cannot expand freely. Ribs, or other strengthening pieces attached to an iron shutter will cause it to warp under heat, and this construction is defective, while the provision of sufficient room for expansion of the whole shutter will avoid the tendency to buckle under heat. A plain steel shutter, well secured and proportioned, will be

found to give good protection against fire from without, while for extra protection Mr. Freeman recommends two shutters, the outer one receiving the brunt of the heat and the inner one thus being able to stand out against the duration of almost any fire.

Mr. Freeman gives some excellent advice about the methods of making buildings fireproof against exposure fires, and the suggestions he gives are open to the use of every one, and so may well be generally observed.

"The path of safety from exposure fires for office buildings and the like, lies in a window casing formed so that we can attach to it a shutter of a form similar to the ordinary inside house-blind. Our ordinary business buildings have walls thick enough so that by making the shutter in four folds, or leaves, two being hinged together, and these two in turn attached to the wall, making each fold in the shutter only about 15 ins. wide, the window will be wide enough for all practical purposes, and we can fold the shutter back with the window jamb, very much as we do the inside blind.

"To do that with the ordinary tin-clad shutter would be almost impossible, because of the thickness of that form of shutter. It can be done with a steel plate shutter without ribs, and the radiation from the inside can be checked by some thin incombustible porous covering like asbestos board. If in our underwriters' laboratories, in our technical schools, and in our tours of survey we can direct attention to these views and urge the solution of the problem of how to make an efficient fire shutter which shall only be ¾-in. or 1 in. in thickness, I believe that before long the problem of protecting an office building against exposure fires will be found solved.

"It is entirely possible to design a window opening adapted to receive a safe shutter, so that it will be just as convenient for ordinary business purposes as the type now common. I think it probable that the best place for the shutters is inside the glass, sacrificing the glazed sash outside them in case of any great conflagration.

"We hear a good deal nowadays about 'water curtains,' and I would like to say just a word on that, because I think there is a gerat deal of misapprehension about their efficiency. I would like to say a word about wire-glass also, because, although in general excellent, I think there is a great misapprehension as to what wire-glass can do.

"I began experimenting with wire-glass very soon after it first came out, and I have used it in numerous instances, and it is a most excellent material in its way, but it has its limitations; it has the same limitations that a water curtain has, and that is, that it does not stop the passage of radiant heat.

"You all have noticed how, when you are traveling in a railway train, perhaps at 60 miles an hour, and they happen to be burning a pile of ties along the track, that although your face is directed towards your newspaper, you will feel the flash of heat passing through the car window and striking against your face as you go past that pile of burning ties. That simply illustrates the great ease and rapidity with which radiant heat passes through glass.

"Now, radiant heat passes through glass with wire netting in it almost as easily as it does through any other glass, and the record made by wire-glass in a certain building in Baltimore, which is pointed to with so much pride, is, I think, simply due to the fact that it was at a place where nothing combustible was immediately behind it. If you have a stock of dry goods, or wooden ware, or baled cotton or hemp just inside a wire-glass window without shutters, and there is a hot fire across the street, these can probably be set on fire with much promptness by the radiant heat passing through the glass, and the subject should be thoroughly studied on a large scale in our underwriters' laboratories. For safety, there must be something which will stop the radiant heat, and that can only be in the form of a shutter, and, by virtue of stopping the heat, the shutter will become hot.

"The case with the water curtain is very much the same as with the glass. Water is diathermous, as physicists call it—that is, radiant heat passes through water very easily. We must, I believe, set down these stories that have been told about the efficiency of water curtains as being mainly fairy tales.

"This supposed efficiency of the water

curtain is another topic which I hope that some one of our underwriters' laboratories and some of our schools of applied science will take up and investigate with precision of measurement.

"I have heard stories of the wonderful efficiency of the water curtain, but I must beg to disbelieve them, largely on the theoretical ground as yet. It is a matter which can be tested very easily.

"The window sprinkler came in for a good deal of praise in certain quarters in Baltimore. I took particular pains to investigate that, because I wanted to find just how far they merited it, and I have no doubt they did some good, but they are not entitled to anything like the glory that is claimed for them. In short, if you want to provide against an exposure fire, I believe that the only satisfactory way to do it is:

"First, by a wall either of brick or cement concrete.

"Second, by properly designed window openings and window casings, and

"Third, by good shutters in those windows.

"In the absence of shutters, automatic sprinklers, supplemented by heroic efforts with hose streams on the inside, may sometimes save the day; with great expense for water damage, but where exposures are bad, a good shutter on a proper window should be the first care of architect and owner."

POWER GENERATION FROM HEAT.

RECENT IMPROVEMENTS IN METHODS AND MACHINES FOR THE CONVERSION OF HEAT INTO MECHANICAL ENERGY.

Prof. E. Josse—Verein Deutscher Ingenieure.

AT the Paris exposition in 1900 there was a notable display of steam engines, gas engines, and motive-power machinery generally, representing very completely the advanced state of the art as it then existed. During the few years which have elapsed a notable advance has been made in this department of engineering work, and in an address delivered before the Berlin section of the Verein Deutscher Ingenieure, and published in the *Zeitschrift* of the society, this recent development is discussed by Professor Josse.

It is unfortunate that the exposition at St. Louis does not contain a sufficiently complete display of motive power machinery to supplement that at Paris, and the absence of the most important feature of that progress, the large internal-combustion motor, makes the record of the St. Louis exposition disappointingly incomplete to the engineering profession. The paper of Professor Josse, however, reviews the field very completely, and it is to be hoped that it may in some degree supplement this unfortunate deficiency.

The competition of the gas engine has led the builders of steam engines to put forth their best efforts to meet, as nearly as may be, the high economy of the internal-combustion motor, and Professor Josse calls attention to the fact that this rivalry has caused a marked advance in steam-engine performance to be attained. The high economy of certain large steam engines still represents the best performance, but the character of the smaller engines, and the general average of steam economy in practical service has been raised much closer to the higher limit.

As an illustration of modern steam machinery Professor Josse describes the new mechanical laboratory of the technical high school at Danzig, the equipment including several varieties of boilers, a compound horizontal steam engine, a steam-turbine generating set, and a variety of auxiliary machinery. The tests which can be made on such motors shows definitely what may be expected in actual practice, and an important result of the establishment of such laboratories is their education influence upon steam users.

To show the progress which has been made in steam economy in a class of engines in which high performance has not often been considered, the results of tests upon improved portable engines are given. A compound, condensing, semi-portable engine by Wolf, of 45 horse power, using steam at 170 pounds per square inch, superheated 300° C. before entering the high-

pressure cylinder, and reheated 190° C. between the high and low pressure cylinders, was tested by Professor Josse, and showed a steam consumption of 4.55 kilogrammes per indicated horse power, or 10.03 pounds, and a coal consumption of 0.556 kilogrammes per indicated horse power, or 1.225 pounds.

These results approach those which have been attained by gas engines, and Professor Josse gives in comparison data and results of tests of a 450 horse power Otto-Deutz gas engine, using producer gas, showing a coal consumption of 0.83 pound at full load, and 1.1 pounds at half load.

The introduction of suction gas-producer plants, operating directly in connection with the engines, is rendering the employment of gas engines much more convenient than when the construction of a complete gas-making installation was required, while the utilization of waste furnace gases is now an accomplished fact in daily service, both in Europe and America, although the single large gas engine designed for such service was regarded as the great curiosity at the Paris exposition in 1900. Professor Josse estimates that the gas produced per ton of pig iron manufactured will give about 1,000 horse power, if used in properly designed gas engines, while but 300 horse power would be obtained by burning the same gas under steam boilers. This estimate is somewhat larger than others have made, the figures given by Mr. Uehling, at the New York meeting of the American Society of Mechanical Engineers, being about 840 horse power per ton of iron made, but the gain of the gas over the steam engine in this connection is undoubted. Illustrations of a number of the larger gas engines of recent design by the leading makers are given in the paper, and details of arrangement and of gas purifying plant.

Professor Josse discusses the rivalry of the steam turbine with the reciprocating engine, and gives a number of curves showing the comparative performance. These demonstrate that the turbine is even now giving as high results as the reciprocating engine, so that the advantages as to space, maintenance, convenience, etc., are additional gains. By the use of the low-pressure turbine of Rateau, in connection with his steam accumulator, the large losses now incurred with winding engines, pumps, and other intermittent reciprocating engines, may be prevented, and plants already installed may have their economy greatly improved.

It is to be expected that Professor Josse would make some reference to his own "waste-heat" engine, this being a form of binary-vapor engine already discussed in these pages. As is well known, in these engines the heat of the exhaust from a steam engine is used to vaporize a volatile liquid which is employed in a second engine, this vapor being then condensed and used repeatedly. The engine of Josse uses sulphurous acid for the second engine, and several installations of the system are shown in the paper. There is no doubt that this method may be used to advantage to render a wasteful steam engine more economical, by recovering a portion of the heat energy passing out with the exhaust, but the economy of such a combination does not appear to be higher than can be attained with the best modern single steam engines.

Practical experience, however, both in Europe and America, with binary-vapor engines, using ether, ammonia, bisulphide of carbon, and similar volatile liquids, appear to show that the gain in power is hardly commensurate with the increased complication and expense, and that the system has but limited application.

In general, the progress which has been made in heat motors during the past few years has been shown to be marked, and this is of especial interest when it is realized that the advance has been along the lines of scientific investigation. The practical engine builder, whether constructing reciprocating engines, steam turbines, or internal-combustion motors, has availed himself of the latest scientific researches, and instead of attempting to devise something in the nature of a startling invention has simply applied, to the best extent of his resources, the results of studies in thermodynamics for the conversion of heat energy into mechanical energy. The result has been a steady progress, advancing step by step, and enabling a continually increasing proportion of the sources of power in Nature to be directed to the use and convenience of man.

THE TEHUANTEPEC RAILWAY.

THE COMPLETION OF THE RAILROAD BETWEEN THE ATLANTIC AND PACIFIC OCEANS ACROSS THE ISTHMUS OF TEHUANTEPEC.

E. L. Corthell—Railroad Gazette.

AMONG the various routes by which it has been proposed to join the commerce of the Atlantic with the Pacific, the Tehuantepec isthmus has long been considered. It has even been proposed to cut a ship canal across at this point, and the late Captain Eads designed a ship railway, and worked out the details in a very complete manner in connection with this route. Apart from the consideration of the isthmus as a possible point for interoceanic communication, however, it offers numerous advantages as a route for the railway development of this portion of Mexico, and hence the plans for a railway have, with numerous vicissitudes, been carried along until the work is now nearing completion. The present state of the project is very fully described in a paper by Mr. E. L. Corthell in a recent issue of the *Railroad Gazette*, from which we make an abstract.

The railway, which will be completely ballasted by the close of the present year, extends from the port of Coatzacoalcos, on the Gulf of Mexico, to Salina Cruz, on the Pacific ocean, a distance of 180 miles. The principal work then remaining to be done will be the improvement of the harbors at the terminals, for which it is estimated that ten million dollars in gold will be required. The work is being conducted by Messrs. Pearson & Sons, of London, in partnership with the Mexican Government, and it will now undoubtedly be pushed to a completion as a portion of the railway system of the republic of Mexico.

It is the view of the contractors and the government that the Tehuantepec Route will be entirely completed and in full operation with its own line of steamships eight years before the Panama Canal can possibly be opened to interoceanic traffic; that the Tehuantepec Route has immense geographic and navigation advantages over Panama and that it can easily draw to itself in the eight years all the traffic naturally tributary to it, and that, even after the opening of the Panama Canal, its excellent facilities for the prompt and economical handling of freight from ship to car and car to ship, will enable it to hold all it will have acquired; also that the ever-increasing volume of the world's commerce and of interoceanic traffic will enable the Tehuantepec Route to acquire its share of this increase, sufficient to make the great investments of the Government yield a fair return. It may be stated also that the Government of Mexico and its people have always believed it was their duty to the world to develop what they believe to be the natural and most advantageous route for the commerce of the world to pass between the oceans.

Mr. Corthell relates at length the history of the various plans which have been made since the days of Cortez, to effect a highway across the continent at Tehuantepec, and shows that the failure of many of the schemes to materialize has been due to the unsettled political condition of the locality. The concession under which the present line has been built was originally granted to Mr. Edward Learned, of New York, by whom 35 kilometers of the line were constructed. At the expiration of the period, in 1882, the property was purchased from Mr. Learned by the Mexican government, and the authorities then proceeded to complete the railroad.

"The ascent from the Gulf of Mexico is gradual, over slowly rising land, to the table land, where the summit is about 924 feet above sea level. The descent to the Pacific plains is much more abrupt. The plains on the Atlantic slope are, however, undulating and are traversed by many lateral streams of considerable size, tributary to the Coatzacoalcos, which is the main drainage of an extensive country subject to an annual rainfall of about 100 inches. The irregularities required in the preliminary construction an undulating grade and considerable sharp curvature. The heavier grades were from 1½ to 2 per cent. and the maximum curvature about 9 degrees about 600 feet radius. The work of the present contract consists largely in cutting down un-

necessary grades and in improving the alinement. The whole length of the route is 290 kilometers (180 miles). The gage is the standard of the United States—4 feet 8½ inches.

"The rail originally laid was 56 pounds per yard. That required by the present contract is 80 pounds. The original rail is all being renewed. The bridges were mostly wooden trestles and pile bridges, except over large rivers. Permanent structures, masonry or steel, are now being substituted for them. The entire line is being ballasted, sidings are being lengthened, yards laid down and the whole route put into shape for a heavy interoceanic traffic, and the rolling stock is being supplied to meet the requirement."

An interesting feature of the route appears in the fact that at Sta. Lucretia, about half-way across the isthmus, the new line connects with the Vera Cruz and Pacific Railroad, and through this with the general railway system of Mexico, extending to the frontier of the United States. This makes a long link in the proposed Intercontinental Railway from New York to Buenos Ayres, and adds materially to the importance of the new line. So far as the Intercontinental Railway is concerned, it has been argued that this line, if ever completed, cannot expect to compete with a deep-water rival, but there appears to be no reason why the development of the country through which the line passes should not be taken into consideration.

Mr. Corthell describes at some length the plans which have been undertaken for the improvement and development of the harbors at the two terminals, and this is a matter of especial importance, since the merchandise transmitted by this route will have to be unloaded and reloaded at each end of the line.

"It is assumed that at Tehuantepec the methods of handling cargo are the best and the quickest now employed anywhere. If the steamers built for this route are designed like the Morgan line steamers running to New Orleans and Galveston from New York, they will be able to discharge or load 5,000 tons of freight on board cars or on board ship in ten hours. This is done regularly at Algiers, opposite New Orleans. Each of the three under decks for freight has great side ports hermetically sealed on the voyage, but opened up as the steamer lightens up in discharging. These ports are high enough so that a gang of men can truck the freight out of the ship into the cars, which have their floors at the level of the wharf floor. When the upper deck has been unloaded the ship lightens up out of the water sufficiently to allow the next set of side ports to be swung open, and so on to the third. Heavy freight—machinery, etc.—which cannot be readily trucked out is stored near the hatchways and lifted out by the ship's tackle and loaded on flat cars, which stand on a track immediately under the ship's side. The steamers are loaded from the cars in the same manner and in the same time. Ten hours will suffice to transfer a cargo of 5,000 tons from the steamer to a train of cars and start it on its journey over the Isthmus."

The additional cost of the handling, Mr. Corthell believes, will be more than overcome by the fact that there is an advantage of four days' time between New York and San Francisco over the Panama route. Assuming a traffic of 6,000,000 tons as available for trans-isthmian business at the present time, Mr. Corthell believes that in the eight years' start which it will have, the railway will be able to secure at least one-half of this business, and to hold all that it has acquired, even after the Panama canal is completed and in full commercial operation.

BOILER-HOUSE ECONOMIES.

THE PROBLEM OF PRODUCING ELECTRICAL ENERGY FROM STEAM POWER AT A MINIMUM COST.

R. S. Downe—Municipal Electrical Association.

AT the recent Sheffield meeting of the Municipal Electric Association a very practical paper upon boiler-house economies was presented by Mr. R. S. Downe, from which we give some abstract.

"The problem is to deliver a unit of electricity at the station busbars, with the maxi-

mum number of lb. of coal, and this question is the most difficult one the engineer has to face in the power house, but the one most likely to give the best money return for the time expended on it. Coal in some cases accounts for 50 per cent. of the total costs. The great majority of stations burn bituminous slack, costing from 6s. to 12s. per ton delivered in the bunkers. Where the railway rate is high and smoke conditions stringent, Welsh coal is used; in a few cases where it is available, smudge, or low grade fuels are burned. This point is entirely settled by local conditions.

"Assuming bituminous slack is used in a well-designed condensing station, with economisers and superheaters, and a load factor not less than 15 per cent., coal ought not to exceed 5 lbs. per unit, including all the losses between the furnace and the engine. Several private industrial plants are now generating a unit of electricity with 3 lbs. of cheap slack. The results are excellent, but under the same conditions one could do better.

"It is necessary to have a rigid weekly analysis of units generated, together with coal and water used. It is possible for all to obtain the weekly consumption of coal, and thereby calculate the lb. of coal per unit generated."

Mr. Downe examines the effect of output and load factor, showing especially the pronounced effect which a bad load factor has upon boiler-room losses. He recommends the use of the minimum number of boilers possible, helping them over the peak of the load by some form of assisted draught. He also discusses the personal factor as shown in the varying performances of different firemen and believes that the adoption of a bonus system will be of value in securing the best work from the men.

In regard to the value of superheating Mr. Downe has some very definite opinions.

"No practical difficulties are experienced in using a moderate superheat up to 500° F. The saving in coal and steam may amount to between 10 and 20 per cent., and is greater where the engines are working under uneconomical conditions, and where a steam ring is in use, or the steam ranges are inordinately long. A superheater attached to a boiler may abstract 10 per cent. of the heat in the flue gases, and reduce the efficiency of the boiler by this amount; but as this 10 per cent. extra heat in the steam may reduce the engine losses by 20 per cent., the net gain is very great, and alone would warrant adoption. The saving in steam is greater than the saving in coal, due to fuel being required to obtain the superheat."

So far as mechanical stokers are concerned, there does not appear to be any very great economy shown by their use. When the coal has to be thrown into the hoppers by hand, there is no saving in labor, and the interest, depreciation, and operative charges go far to offset any actual economy in performance.

Mr. Downe touches upon a very important source of loss in the matter of air leakages.

"Most boilers are surrounded by a quantity of brickwork which is notoriously porous, and as this brickwork is subjected to great changes of temperature, the air leakage becomes excessive unless it is receiving constant attention. Air leakages being inwards are of an insidious character, as they do not show themselves but have to be searched for.

"When boilers are shut down under natural draught, there is always considerable air leakage into the main-flue, even when the dampers are closed. Sliding dampers require to be an easy fit in their frames, but in most cases this is overdone; an improvement on the usual type of damper might be easily fitted. The brickwork round damper-frames is difficult to inspect; generally on being opened up it is found to pass cold air at every joint. This air has a considerable cooling effect on the gases; it decreases the draught and lowers the economiser efficiency."

The losses due the low efficiency of the auxiliary machinery may be materially reduced in an electric-power station by driving all such machines electrically, and the steam required for these purposes may be reduced from 3.5 per cent. to 1.5 per cent. of the total output.

"In every case where water is treated, it should be done externally, before entering the boiler. For economical steaming, a boiler should be clean inside and out, because the transmission of heat is rendered easier, and the evaporation is increased.

"It is a generally accepted fact that no economy can be obtained by raising the temperature of feed water except by heat which would be otherwise wasted. Is it possible, by having separately fired feed heaters in series with economisers, to put the water into the boilers at the same temperature as the steam, and so obtain more duty per boiler, and reduce the number under steam, thus effecting a saving in coal? The true function of a boiler would then be steam raising, and not feed heating in addition.

"When the boilers and piping have been covered with the most suitable material, it is necessary to have the latter periodically examined and repaired, as it is usually of a perishable nature. When it is enclosed in a metallic envelope, much waste may be caused if there is contact between the piping and the shield, which may be at nearly the temperature of the steam. Condensation may be reduced one-half if the valve bodies and flanges are covered. The joint itself may be left exposed, but with superheated steam there is little trouble from leaky joints, if the ranges are well fitted and properly drained.

"Perfect combustion of fuel cannot be obtained in any form of boiler, but it ought to be possible to considerably raise the low thermal efficiencies at which most of them are working at the present time. The two essentials are:—The highest possible initial temperature in the combustion process, as the heat transmission between the water and the hot gases is directly proportional to their difference of temperature; and a high temperature in the combusion chamber, so that the volatile gases are not cooled down before combustion takes place. To obtain full value from bituminous coal is an exceedingly difficult matter, and the numerous papers which have dealt with this problem do not assist us much.

"The subject is usually dismissed as follows:—'In a properly constructed furnace these valuable hydrogen units can be utilised to their full value, but time does not permit of going further into this matter.' What engineers are seeking is the properly constructed furnace, suitable for the particular class of slack to be burnt.

"Electrical engineers have made great progress in this special branch of steam engineering, due in great measure to the fact that they are the largest purveyors of energy in a form which is readily and accurately measured. Before the advent of electricity supply, these investigations were entirely in the hands of marine and water engineers, who were restricted to measuring their energy in indicated horse-power-hours, which is neither a convenient nor particularly accurate method."

THE GENERATION OF STEAM.

A STUDY OF THE FUNDAMENTAL PRINCIPLES INVOLVED IN THE MANUFACTURE OF STEAM FOR THE GENERATION OF MOTIVE POWER.

A. Lencauchez—Société des Ingenieurs Civils de France.

THERE is appearing at the present time two distinct tendencies in the production of motive power from heat. One of these involves the containing of the entire operation within the motor, and is illustrated by the forms of internal-combustion motors which use liquid fuel directly in the machine itself. Such machines of which the petrol motors, the Diesel and the Banki motors are good examples, are practically self-contained, the entire transformation of the heat into mechanical energy being effected within the motor itself. The earlier steam engines were somewhat of this type, at least to the extent that the engines and boilers were always closely associated and frequently combined, but the present tendency is distinctly toward the construction of large steam generating plants, separating the production of the steam, to a large extent from the machinery by which it is to be utilized. It is this phase of the subject which is treated in a paper presented by M. A. Lencauchez before the Société des Ingenieurs Civils de France, and published in *Mémoires* of the society.

After referring to the increasing size of steam generating units, both in the modern power house and on the large ocean steamships, Mr. Lencauchez calls attention to the increasing importance of compactness,

space being of value both in buildings and in vessels. At the same time, it is generally assumed that large steam boilers operating slowly are more economical of fuel than the modern compact, intensive steam generators, so that there are various conflicting elements to be considered. Broadly, four principal defects in steam-boilers may be considered, in studying the problem:

Boilers of the elephant or semi-tubular construction are far from giving in practice a combustion equal to the theoretical. Again, these boilers abstract very imperfectly the heat from the products of combustion. By reason of defective circulation, some portions of such boilers become dangerously overheated, and finally;

The incomplete combustion results in the production of dense smoke, demonstrating the correctness of the preceding statements.

In examining the elements upon which correct boiler design may be based, Mr. Lencauchez uses data of tests ranging from 1863 to 1894, by such careful observers as Morin, Tresca, Henry, Baudry, Normand, Witz, and others, these showing the results obtained with widely differing types of boilers, over a long period of years. These experiments cover data as to the influence of the proportion of air upon combustion, upon the conductivity of various metals, upon the rate of drop of temperature of the gases in passing from the fire box to the chimney, and upon the influence of variations in design upon boiler performance. Mr. Lencauchez also examines the relative performance of condensing and non-condensing engines, considered with regard to steam economy.

So far as the conductivity of the metal is concerned, we are far from possessing positive information, since nearly all investigations give only the relative conductivity of different metals. Recent experiments, however, enable some practical data to be obtained. Thus, tests made upon copper evaporating coils, and upon triple-effect evaporating vacuum pans, show a transmission of heat ranging from 2,000 to 3,000 calories per square metre per hour, per degree centigrade difference of temperature. Tests upon a Belpaire boiler, evaporating 15,500 kilogrammes of water per hour, with a consumption of 2,000 kilogrammes of coal, show that this performance corresponds to a transmission of only about 100 calories per square metre, per degree, per hour; or only one-twentieth of that attained in the previous tests.

In comparing these and other data bearing upon the question, M. Lencauchez is convinced that it is a mistake to consider the evaporative power of a steam boiler as a function of the heating surface. Apparently no definite relation between these two quantities has yet been accurately formulated. Thus a boiler having 100 square metres of heating surface and a grate of two square metres area will give a certain evaporation. If now the area of heating surface be reduced to 50 square metres, while the grate and rate of firing remain unchanged, the evaporation will be but slightly affected, possibly being reduced about 10 per cent. Thus, in the first case an evaporation of, say, 15 kilogrammes of water per square metre per hour, will become 27 kilogrammes per square metre; showing the inadequacy of the use of the area of heating surface as a measure of evaporative power.

As a matter of fact a surface condenser is expected to convert all the steam evaporated by a boiler back into water again with only about one-fourth of the surface allowed in the boiler, and with a temperature difference of only about 50° C., instead of the 800° existing between the boiler and the hot gases.

A far more important element in the transfer of heat is found in the maintenance of close contact between the heating surface and the water, and methods of design and operation which enable this to be accomplished should be considered. This effect is partially produced by a good circulation, and in some instances mechanical appliances have been added to aid in keeping the water in motion and sweeping the bubbles of steam away from contact with the heating surface so as to permit the water to absorb the heat.

The manner in which the heat is absorbed from the hot gases by the water through the heating surface, has been made the subject of careful study. It has been investigated by measuring the drop in temperature from the fire-box end to the smoke-box in the tubes of locomotive boilers, and although the result shows an ex-

tremely rapid fall of temperature in that short distance it is by no means so quick as has been sometimes supposed, or than is necessary for the complete absorption of the heat.

Thus, in experiments upon locomotives of the Orleans railway, with tubes 5 metres long, and an air suction of 50 mm., the temperature of 1,600° C. in the fire-box fell to 400° in the smoke-box, this drop of 1200° taking place in one-tenth of a second.

M. Lencauchez examines the construction of a great variety of boilers, together with such auxiliary apparatus as economizers, superheaters, condensers, etc., and his conclusions, which are indicative of the nature of his investigations, are summarized here.

It is evident that we are yet far from utilizing the full conductibility of the metals employed in steam boiler construction. It also appears boilers of intensive action, such as locomotive boilers, and the express water-tube boilers used on torpedo boats and the like, utilize the heat to a better advantage than those which are fired slowly and are slow steamers. For engines working with double or triple expansion, and at the high pressures now possible, the advantages of superheating become less and less, while with properly proportioned boilers there is no real advantage to be gained by the use of economizers.

The condensing engine, as ordinarily constructed, is not materially more economical than the non-condensing type, the advantage due to the vacuum being largely overcome by the cost of getting it. If a practical gain is to be obtained by condensing, it will be best secured by the use of a carefully designed central condenser, with independent pumps, the supply of condensing water and the speed of the pumps being regulated by the vacuum.

The use of a feed water heater and purifier, delivering the water to the boiler at about 96° C., is found to be the most practical device for this purpose, giving a real economy of 9 to 10 per cent. over and above all charges which may properly be made against it.

Some of these views will doubtless be regarded as heretical, but they are based on careful study of existing facts, extending over a long series of years, and freed from the bias which sometimes attaches to arguments by men who are interested in demonstrating the advantages of some especial device. The paper of M. Lencauchez is well worthy of careful study, even if all of his conclusions may not be accepted.

MOTOR BOAT TRIALS.

PRACTICAL EXPERIMENTS UPON THE RELIABILITY OF INTERNAL-COMBUSTION MOTORS FOR THE PROPULSION OF BOATS.

Engineering.

THE so-called motor-boat has increased greatly in vogue during the present season and a large number of small boats are now equipped with machinery similar to that upon road automobiles. Some remarkable results as to speed are reported from time to time, but there has been a general disposition to regard these interesting craft as rather unreliable, and as ready for breakdowns or disabling as their rivals upon the road. For this reason the reliability trials recently conducted in England under the auspices of the Automobile Club under the control of a committee containing such members as Dr. Boverton Lloyd, Sir John Thorneycroft, Mr. F. A. Yarrow, and other experts demand interested attention. From a report of these trials in a recent issue of *Engineering* we give some of the results, and fuller information will doubtless be forthcoming at a later date.

The object of the trials is an important one, being to prove to naval authorities, shipping companies, yacht owners, and the public generally, that boats propelled by internal-combustion engines can be depended upon for continuous running for various purposes; that they can be made a safe, cheap, and reliable means of transport.

The trials were run over a course of 9½ nautical miles long, in Southampton water, and the competitors were required to run over the course continuously for ten hours of each of two consecutive days, making a total run of twenty hours. Marks were

made for reliability, account being taken of every stop; for speed, for safety, and for economy, the boats being divided into six classes, according to size. Sixteen boats were entered, of various sizes and powering, and the motors represented the work of some of the best-known makers in the automobile business. The trials appear to have been made in a very general fashion, the horse-power of the motors being taken upon the builders' representation, no indicating being practicable, while the only dimension taken into account was that of length, beam being neglected, and no handicap nor time allowance being given. Since the main feature under consideration was reliability, however, these points were not material, and in future tests doubtless greater elaboration in requirements will appear.

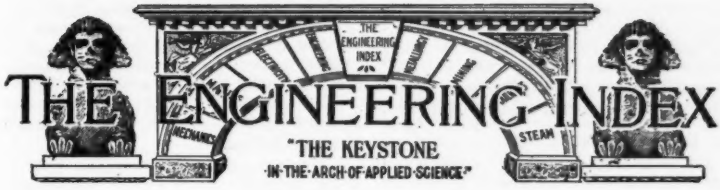
In general the results were very satisfactory, only two boats out of the sixteen being obliged to give up, and these mishaps were not due to any serious defect in the design or construction of the motors. Speeds from 9 to over 14 knots were made by some of the boats, and although full reports of the trials are lacking, the results are most gratifying.

Although most of the boats which have been fitted with internal-combustion motors are of small size at present, there is every reason to believe that these craft will become of very general use and will be built in large sizes, as soon as their entire reliability is established. Many of the conditions which render these small, quick-running motors unreliable on the road are absent on the water. There is no dust to be contended with, and there is ample opportunity for keeping the cylinders cool. The necessity for extreme lightness is absent, so that the operative parts may be made a trifle heavier, just enough to give a good factor of safety, instead of running so close as to leave little margin against sudden and unforeseen strains. The parts may be made more accessible, and many points of convenience may be provided, so that the opportunities for reliable working are far greater afloat than ashore.

With the success of the small motor boat in general service may be expected the development of the internal-combustion motor to larger craft. Petrol or benzine can hardly be available in such cases, but there is every reason to believe that motors using kerosene and the heavy petroleum oils will be made applicable to marine service, and we have already noted the successful use of the Diesel motor in this manner in France.

There is a natural prejudice among nautical men in favor of steam for propulsion, as against the use of the internal-combustion motor, and it must be said that there are some good reasons for such opinions.

"It is a long step from 200 or 300 horse power to the 2,000 horse power of a torpedo boat, still more to the 6,000 or 7,000 horse power of a destroyer; and some very difficult problems remain to be solved. The certainty and flexibility of steam, the ease with which an ordinary steam engine can be reversed, its accommodation to the varying speed of turning, and many other practical points go very far to compensate for the inefficiency of steam, and the drawbacks incident to the boiler. Moreover, we must remember that the great success of the internal-combustion engine for road locomotion has been achieved with petrol, but that is too costly for large powers. Directly we get to a heavier and cheaper fuel the difficulties increase enormously; indeed, the kerosene engine has yet to prove its profitable application, either on wheels or afloat. We remember Sir William White's remarks in his address as President of the Institution of Civil Engineers, and it may be the solution to the problem of the internal-combustion engine afloat may be through solid fuel gasified in producers, which would take the place of steam boilers. A bar to progress in this direction is that advance is hardly to be made from small beginnings, step by step, in the way that technical suggestion is generally translated into commercial practice through the medium of small craft; for we cannot imagine any of the craft in these competitions with gas producers on board. From land to sea is a big jump in engineering practice, but the way in which the use of gas engines is extending is pregnant of suggestion; for instance, one firm alone of Continental makers, and that not in a great engineering centre, has now orders for gas engines of over 500 horse power, to the extent of 80,000 horse power."



The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Bascule.

The Broadway Bascule Bridge at Milwaukee, Wis. John Geist. Illustrated detailed description of a bascule lift bridge, possessing novel features in design and construction. 2000 w. Eng News—July 14, 1904. No. 63831.

Cantilever.

A German Long-Span Cantilever Highway Bridge. Drawing and brief description of the longest span in Germany. 700 w. Eng News—July 14, 1904. No. 63834.

Concrete.

A Concrete Railway Bridge. Illustrated brief description of a bridge on the Illinois Central R. R., near Carbondale, Ill. 1000 w. Trac & Trans—July, 1904. No. 64001 E.

Iron Bridges.

The First Iron Railroad Bridge. F. C. Coleman. Illustration, with the history of a bridge built in 1823 for the Stockton & Darlington Railway in Great Britain. 800 w. R R Gaz—July 8, 1904. No. 63707.

We supply copies of these articles. See page 1037.

Manhattan.

Architectural Features of the Manhattan Bridge. Illustrations, with notes of this bridge across the East River at New York, officially known as No. 3. 1200 w. R R Gaz—July 1, 1904. No. 63626.

The Manhattan Bridge Across the East River, New York City: Revised Plans. Brief illustrated description of proposed changes in the design, with extract from a letter by Carrère & Hastings, giving an outline of the reasons for the architectural changes. 1400 w. Eng News—July 7, 1904. No. 63701.

Movable Bridges.

Movable Bridges. George H. Norton. Considers recent economic changes, and the present tendencies in design, noting the limitations and some of the objects sought. Ills. 5300 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63609 F.

Plate-Girder.

The Erection of a Three-span Plate-Girder Bridge. Illustration, with brief description of the construction of the bridge at Newark, N. J., which carries the tracks of the Central R. R. of N. J. across the Pennsylvania R. R. 2000 w. Eng Rec—July 23, 1904. No. 64048.

Progress.

Progress in Railroad Bridge Building. F. C. McMath. Address before the Detroit Engng Soc. Reviews the progress made in this field in the United States, and some of the causes of the changes in design, with information of interest. 1800 w. Jour Assn of Engng Socs—June, 1904. No. 64135 C.

Reinforced Concrete.

Reinforced Concrete Bridge at Soissons (Pont en Béton Armé à Soissons). M. Riboud. The bridge is of three arches of 24 metres span each, on the Hennebique system. Description of tests and diagrams of deflections are given. 2000 w. Génie Civil—June 18, 1904. No. 63914 D.

Some Observations of the Design of Reinforced Concrete Bridges. W. J. Douglass. Gives suggestions based on observations during a trip made for the purpose of inspecting concrete and concrete-steel bridges. 1700 w. Eng News—July 14, 1904. No. 63836.

Rhine.

The Competition for a Highway Bridge Over the Rhine Between Ruhrort and Homberg (Der Wettbewerb um eine Feste Strassenbrücke über den Rhein zwischen Ruhrort und Homberg). Karl Bernhard. With description of the requirements of the competition and illustrations of some of the designs submitted. Serial. Part I. 1800 w. 2 plates. Zeitschr d Ver Deutscher Ing—July 2, 1904. No. 63904 D.

The Construction of a Highway Bridge Over the Rhine Between Ruhrort and Homberg (Die Erbauung einer festen Strassenbrücke über den Rhein zwischen Ruhrort und Homberg). F. Bohny. Describing the situation and illustrating some of the proposed designs. 2000 w. Schweiz Bauzeitung—June 18, 1904. No. 63967 B.

Swing Bridge.

The Reconstruction of the Rye Swing Bridge. E. R. Waight. Illustrated description of the new bridge over the Rother River. 2200 w. Engr, Lond—July 15, 1904. Serial. 1st part. No. 64098 A.

Viaducts.

Notes on a Foreign Contract. A. B. Lueder Concerning the contract for twenty-seven viaducts in British East Africa on the Uganda Railway, awarded to the American Bridge Co., of New York. Ills. 3300 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63608 F.

CONSTRUCTION.

Armory.

The Seventy-first Regiment Armory Building, New York. Illustrated description of a brick, stone and steel structure about 96 feet high, with tower over 300 feet above the street. 3800 w. Eng Rec—July 2, 1904. No. 63658.

Bins.

Some Formulas and Tables for Bin Designing. R. W. Dull. A summary of the principal formulas required, with tables of pressure-constants for several cases of bins or hoppers for anthracite, bituminous coal, ashes, and sand. 2500 w. Eng News—July 21, 1904. No. 64037.

Building Construction.

Sky-Scrapers. Arthur W. French. Considers the construction of tall steel-framed buildings, and the engineering problems involved. 5200 w. Jour Worcester Poly Inst—July, 1904. No. 63810 C.

The Engineer, the Architect, and the General Construction Company. Reginald Pelham Bolton. An arraignment of the abuses existing in the present practice of conduct of the engineering portions of modern building construction. 3000 w. Engineering Magazine—August, 1904. No. 63975 B.

The Railway Exchange Building, Chicago, Ill. Illustrations, with brief description of a fine building to meet the needs of the railroads centering in Chicago for general office purposes. 500 w. Archts & Builders' Mag—July, 1904. No. 63712 C.

Concrete Work.

Forms for Concrete Work. G. R. Wadsworth. Illustrates and describes types used. 600 w. R R Gaz—July 8, 1904. No 63708.

We supply copies of these articles. See page 1037.

Fire Protection.

An Engineer's Suggestions to Fire Underwriters. John R. Freeman. Address at the banquet of the Nat. Board of Fire Underwriters, New York. On lessons from the Baltimore fire. 4800 w. Am Archt—July 16, 1904. No. 63850.

Shutters and Other Devices for Protection Against Exposure Fires. John R. Freeman. Extracts from an address before the Nat. Board of Fire Underwriters, New York. Facts learned from a study of the Baltimore fire. 2200 w. Eng News—July 14, 1904. No. 63835.

The Recent Conflagration in Baltimore. C. L. Norton. Calls attention to technical lessons to be learned from this disaster. Ills. 3500 w. Tech Qr—June, 1904. No. 63875 E.

Reinforced Concrete.

Concrete-Steel Stairway Construction; New York Rapid Transit Railway. Illustrated detailed description of the exit stairways. 700 w. Eng News—June 30, 1904. No. 63587.

Cross-Bending Tests on Beams of Reinforced Concrete. Malverd A. Howe. Gives results of a series of tests. The object was to obtain the actual strength in cross-bending of full-size concrete beams reinforced with corrugated bars, according to the formula of A. L. Johnson. 1800 w. Jour W Soc of Engrs—June, 1904. No. 64140 D.

Flexure of Reinforced Concrete Beams. W. K. Hatt. An account of experimental tests made by the writer, giving a straight-line formula and a diagram representing equations, with explanations of their use. 4000 w. Jour W Soc of Engrs—June, 1904. No. 64139 D.

Prussian Regulations for Reinforced Concrete in Building Construction. A copy of the regulations sent to the building authorities April 16, 1904. 2200 w. Eng Rec—July 2, 1904. No. 63664.

Reinforced Concrete Beams. Discussion of papers by W. K. Hatt and Malverd A. Howe on tests made of reinforced concrete beams. 18000 w. Ill. Jour W Soc of Engrs—June, 1904. No. 64141 D.

Reinforced Concrete Construction in a Factory Extension at Bayonne, N. J. An illustrated description of extensions made to the factory of the Pacific Coast Borax Company, describing the work. 4400 w. Eng Rec—July 2, 1904. No. 63661.

Tests of Steel-Concrete Beams. Prof. Edgar Marburg. Read before the Am. Soc. for Test. Materials. A report of tests made under the direction of the writer. 3500 w. Eng Rec—July 9, 1904. No. 63783.

The Design of the Steel-Concrete Work of the Harvard Stadium. Lewis J. Johnson. An illustrated article discussing this work in detail. General discussion. 5 plates. 11500 w. Jour Assn of Engng Socs—June, 1904. No. 64132 C.

The Strength of Flat-Plates, with an Application to Concrete-Steel Floor Panels. S. E. Slocum. Develops a rational theory of stress distribution, involving only elementary mathematical principles, and applying the results to the case of a concrete-steel floor panel in actual use. 3500 w. Eng News—July 7, 1904. No. 63705.

See Civil Engineering, Bridges.

Steel Roads.

American Steel Roads. George E. Walsh. On the advantages, construction, cost, &c., of steel roads for city and country, and for automobile use. 2000 w. Gunton's Mag—July, 1904. No. 63618 C.

Timbers.

The Use of Inferior Timbers for Structural Purposes. From a paper read before the Nat. Lumber Mfrs. Assn., at St. Louis, by Hermann von Schrenk. Concerning the strength and lasting powers of inferior timbers, and information related. 1200 w. Eng News—July 28, 1904. No. 64152.

Tunnels.

Relining Winston Tunnel on the Chicago Great Western. An illustrated description of the work of relining with brick and concrete and building retaining walls in the cut. 1000 w. R R Gaz—July 22, 1904. No. 64032.

Underpinning.

Underpinning a High Wall with Steel Cantilever Girders. Illustrates and describes method used at Paterson, N. J., to make safe a mill injured by the severe floods of 1903. 1500 w. Eng Rec—July 16, 1904. No. 63844.

MATERIALS OF CONSTRUCTION.

Building Stones.

A Descriptive Catalogue of the Building Stones of Boston and Vicinity. W. O. Crosby and G. F. Loughlin. A study with regard to the durability and adaptability. 9000 w. Tech Qr—June, 1904. No. 63876 E.

Cement.

An Apparatus for the Direct Determination of the Specific Gravity of Cement. Daniel D. Jackson. Read before the N. Y. Sec. of the Soc. Chem. Ind. Illustration, with description of new apparatus, requiring only ten minutes to make a determination, and giving an accuracy to 0.01. 1200 w. Eng Rec—July 16, 1904. No. 63848.

Some Notes on the Boiling Test of Cement. Frederick H. Lewis. Read before the Am. Soc. for Testing Materials. Deals with advantages arising from variations in the composition of the cement. 1600 w. Eng Rec—July 2, 1904. No. 63667.

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Explosives.

The Storage of Explosives in Densely Inhabited Areas. A paper by Capt. Thompson, read at the International Fire-Prevention Congress. Deals with the precautions enjoined by English law. 7000 w. Am Archt—July 23, 1904. No. 64056.

Fire-Proofing.

Fire-Resisting Materials. An illustrated article discussing the materials used in buildings and reporting the success of so treating fabrics and stage properties as to render them safe. 4000 w. Fire & Water —July 9, 1904. No. 63717.

Paints.

Results of an Investigation of the Durability of Paints for the Protection of Structural Work. Robert Job. An illustrated report of these investigations, which seem to show that fineness of pigment is of great importance in securing desirability of paint. Also discussion. 6500 w. Jour Fr Inst—July, 1904. No. 64015 D.

Slag.

Blast Furnace Slag as a Structural Material. Jos. A. Shinn. Reviews the uses that have been made of blast-furnace slag, and reports tests made of slag sand. General discussion. 6500 w. Pro Engrs' Soc of W Penn—April, 1904. No. 64130 D.

White Lead.

Contribution to Our Knowledge of White Lead and of Its Protecting Properties. Augustus H. Gill and Stanley A. Foster. A report of experimental investigations. 800 w. Tech Qr—June, 1904. No. 63874 E.

Wood Preservation.

The Preservative Treatment of Wood. Samuel P. Sadtler. Remarks on the structure and chemical composition of wood, with discussion of the methods of treatment to prevent decay, and the results. Ills. 5500 w. Tech Qr—June, 1904. No. 63873 E.

MEASUREMENT.

Curves.

Methods for Determining the Equations of Experimental Curves. A. S. Langedorf. An examination of methods of analysis, illustrating by examples. 2200 w. Jour Assn of Engng Socs—June, 1904. No. 64-133 C.

Steel Tape.

Steel Tape Measurements on the Massachusetts Boundary Line, 1886 to 1898. N. Spofford. An illustrated article describing the work and showing the operation of the devices used. 2000 w. Eng Rec—July 16, 1904. No. 63849.

Surveying.

Report on the Triangulation of Oneida Lake. Charles E. Curtis. A description of the work, the instruments used, the cost, etc. 2800 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63610 F.

Surveying-Instruments.

Additional Remarks on Surveying Instruments. H. D. Hoskold. Remarks on Thornton's improved miner's dial, the Grubb-Davis mine-surveying dial, and micrometer stadia-measurement. 1000 w. Trans Am Inst of Min Engrs—Feb, 1904. No. 64145.

MUNICIPAL.

Havana.

Sanitary Engineering in Havana. Chester C. Torrance. Gives a map of the city describing its former condition and the improvements made while the island was under the care of the United States; also discusses needed improvements. 6000 w. Trans Assn of Civ Engrs of Cornell Univ —1904. No. 63607 F.

Laboratories.

The Philadelphia Municipal Testing Laboratories. W. Purves Taylor. Describes the work carried out at these laboratories. 1300 w. Eng Rec—July 2, 1904. No. 63663.

Pavements.

Effect of Heat Upon Asphaltum in Paving Mixtures. F. O. Blake. Shows how easily asphalt may be ruined by overheating. 1000 w. Munic Engng—July, 1904. No. 63630 C.

The Available Paving Material. John W. Alvord. Briefly considers asphalt, wood, brick, bitulithic and stone. 3800 w. Munic Jour & Engr—July, 1904. No. 63-713 C.

Sewage.

The Nitrifying Organisms in Sewage Filters. Dr. Schultz-Schultzenstein. Translated from the German. Describes investigations, isolating and studying the nitrifying bacteria in sewage filters, and comparing them with nitrifying organisms in cultivated fields. 7800 w. Tech Qr—June, 1904. No. 63877 E.

The Purification System of the Sewerage of the City of Baden (Ueber die Reinigung Städischer Abwässer und die Reinigungsanlage der Stadt Baden). Thomas Hofer. A review of sewage purification systems, with a detailed description of the plant of the city of Baden. Two articles. 2 plates. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—July 1, 8, 1904. No. 63926 D.

Sewers.

Large Relief Sewers in Brooklyn. Illustrates and describes improvements in the old sewer and the trap basin at the head of Gowanus Canal, and the construction of relief sewers. 4800 w. Eng Rec—July 16, 1904. No. 63846.

We supply copies of these articles. See page 1037.

Street Sprinklers.

Automobile Street Sprinkler. Brief illustrated description of an automobile sprinkler, now in use in Paris. 800 w. Sci Am—July 30, 1904. No. 64155.

WATER SUPPLY.

Algae.

Removal of Anabaena from Reservoir Water. An account of the trouble with this species of algae at the Ludlow water supply of Springfield, Mass., and the investigations made for the purpose of eliminating the trouble. 2000 w. Eng Rec—July 2, 1904. No. 63659.

The Copper Sulphate Treatment for Algae at Elmira, N. Y. James M. Caird. An account of the treatment and the cost. 900 w. Eng News—July 14, 1904. No. 63833.

Arabia.

The Ancient Water-Tanks of Aden, Arabia. Arthur Stanley Riggs. Brief illustrated description of these interesting old reservoirs. 1100 w. Eng News—July 14, 1904. No. 63830.

Control.

The Administration and Control of the Nation's Water Supply. R. E. Middleton. Abstract of a paper read before the British Assn. of W.-Wks. Engrs., and of the discussion. Discusses the present British laws bearing on this subject, and the need of their revision. 4300 w. Jour Gas Lgt—July 5, 1904. No. 63765 A.

Dams.

Concrete Work on the New Croton Dam Extension. Illustrated description of the construction work. 2800 w. Eng Rec—July 9, 1904. No. 63780.

Rubble Concrete Dam for the Atlanta Water & Electric Power Co. Illustrated detailed description of an interesting construction. 1800 w. Eng News—July 7, 1904. No. 63703.

Filters.

Base Lines for Construction of Torresdale Filters, Philadelphia. John A. Vogelson. Describes the methods used. 1500 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63605 F.

Open Slow Sand Filters at Yonkers, N. Y. Illustrated detailed description of filtered water basin, gate chambers, filter beds and piping. 2500 w. Eng Rec—July 2, 1904. No. 63665.

The Lower Roxborough Preliminary Filters. P. J. A. Maignen. Reviews the various methods of filtration, giving the reasons for the preliminary filters at Philadelphia, and the principles involved, with details of construction and operation. Ills. 16000 w. Pro Engrs' Club of Philadelphia—July, 1904. No. 64128 D.

Fire-Hose Couplings.

A Suggested Standard Number-Code for Hydrant and Fire-Hose Couplings. C. E. Loetzer. Notes the difficulties to be met in establishing a uniform size, and gives a system for standardizing the existing varying sizes. 1500 w. Eng News—July 21, 1904. No. 64039.

Lynchburg, Va.

Concrete Dam and Wood-Stone Conduit for Lynchburg Water-Works. An account of steps being taken to furnish a gravity supply of better quality than the river water now used. Begins an illustrated detailed description of the dam. 3000 w. Eng Rec—July 23, 1904. Serial. 1st part. No. 64052.

Meters.

To Meter or Not to Meter. J. de Bruyn Kops. Also editorial. The facts given are based on an article by Morris Knowles, published in the *Engineering Record* of May 14, 1904. Objections are made to the conclusions reached. 3000 w. Munic Engng—July, 1904. No. 63629 C.

The Meter System in Cleveland. Edward W. Bemis. On the methods used to popularize water meters, their rapid installation, how to prevent freezing, cost, effect, &c. Ills. 4500 w. Munic Jour & Engr—July, 1904. No. 63714 C.

New York.

The Need of Prompt Action on New York's Additional Water Supply. Excerpts from remarks of Mr. Freeman in an address before the Nat. Board of Fire Underwriters, with comments on the pressing need of more water for New York City. 2000 w. Eng News—July 14, 1904. No. 63838.

Pipes.

Resistance Due to Bends in Pipes. John C. Trautwine, Jr. Reports investigations made of the resistance to the flow of water by various pipe connections. 700 w. Eng Rec—July 2, 1904. No. 63666.

Pumping Engines.

See Mechanical Engineering, Hydraulics.

Pure Water.

The Practical Definition of "Pure and Wholesome Water" and "Pollution." John C. Thresh. Read before the British Assn. of Water-Works Engrs. Also abstract of discussion. 3500 w. Jour Gas Lgt—July 12, 1904. No. 64009 A.

Reservoirs.

Concrete and Puddle Core Walls for Reservoir Embankments. William Watts. Abstract of a paper before the British Assn. of Water-Works Engrs. Discusses the use of concrete in preference to clay puddle, giving the authors recommendations; compares the cost, and describes

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construction. 2000 w. Eng News—June 30, 1904. No. 63588.

Jerome Park Reservoir Gatehouses and Concrete Lining. An illustrated article describing details of the gatehouses of this large New York reservoir, and of the lining of the bottom and slopes. 1800 w. Eng Rec—July 23, 1904. Serial. 1st part. No. 64054.

Waste.

Water-Waste Prevention in Great Britain. A comparison between the conditions governing water consumption in Great Britain and the United States. 3000 w. Eng News—June 30, 1904. No. 63589.

Worcester, Mass.

Water Supply at Worcester, Mass. F. A. McClure. Map, with illustrated description of the present supply, and outline of the history. 3000 w. Munic Eng—July, 1904. No. 63631 C.

WATERWAYS AND HARBORS.

Channels.

The Improvement of the St. Lawrence River Ship Channel. Reviews the work done on the channel of the St. Lawrence River between Montreal and Quebec. 1500 w. Eng News—July 28, 1904. No. 64151.

Crane.

Floating Crane of 100 Tons Capacity (Schwimmkran von 100 t Trägfähigkeit und 150 t. Probelast). Describing and illustrating an improved form of shears with trussed members as built for the harbor of Dantzig. A test load of 150 tons was applied. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—July 2, 1904. No. 63905 D.

Dams.

Failure of Oakford Park Dam Across Brush Creek, Near Jeannette, Pennsylvania. Harrison Souder. An illustrated description of the dam and the accident, with suggestions for safer construction. General discussion. 3500 w. Pro Engrs' Club of Phila—July, 1904. No. 64127 D.

The Chesuncook Timber Dam. J. W. Tower. Illustrated description of the construction of a dam in Maine. 900 w. Eng Rec—July 16, 1904. No. 63845.

See Civil Engineering, Water Supply.

Dock Plant.

Electrical Plant at Heysham Harbor. Illustrated description of the plant at this large, new harbor built by the Midland Railway Co. In addition to arc and incandescent lighting current is supplied for the electric cranes capstans, lifts, &c. 2000 w. Elect'n, Lond—June 24, 1904. Serial. 1st part. No. 63646 A.

Docks.

The Southampton Docks and Cold Storage Plant of the London and Southwestern Railway. Illustrated detailed description of one of the finest docks in the world and one of the most complete cold-storage warehouses. 6000 w. Ry Age—July 1, 1904. No. 63718.

Dover.

Dover as a Port of Call. A brief illustrated account of the construction of a portion of the new harbor works. 2200 w. Transport—July 8, 1904. No. 64022 B.

Dredges.

Government Dredges for New York Harbor. Illustrated detailed description of two large suction sea dredges intended for deepening the channel. 1500 w. Marine Engng—July, 1904. No. 63620 C.

Heysham.

The Completion of Heysham Harbor. An illustrated article describing the final completion of this new port of the Midland Railway. 2500 w. Transport—July 8, 1904. No. 64020 B.

Panama.

Natural Conditions Affecting the Building of the Panama Canal. Gen. H. L. Abbot. A study of the data relating to the climate and rainfall of the isthmus which solve the problems of water supply and control. 3500 w. Engineering Magazine—August, 1904. No. 63971 B.

Pier.

Folkestone New Pier and Harbor Works. Illustrated description of these interesting works, recently completed. 6500 w. Engng—July 8, 1904. No. 63890 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

New Telephone Exchange at Buda-Pest, Hungary. Joseph Hollos. An illustrated detailed description of the installation. 2200 w. Elec Wld & Engr—July 16, 1904. No. 63840.

The New Holborn Telephone Exchange. Illustrated description of the special features of an installation of the central battery system. 3000 w. Elec Rev, Lond—July 1 1904. No. 63748 A.

Printing Telegraph.

The Baudot System for Submarine Cables (Baudot betrieb in See-Kabel-leitungen). Describing the application of the Baudot printing telegraph apparatus to the cable between Marseilles and Algiers.

We supply copies of these articles. See page 1037.

3000 w. Elektrotech Zeitschr—June 30, 1904. No. 63960 B.

Space Telegraphy.

The Distribution of Time by Wireless Telegraphy (Sur la Distribution de l'Heure à Distance au Moyen de la Telegraphie Electrique sans Fil). G. Bigourdan. Describing successful experiments in the distribution of timed impulses through space by electric discharges, made at Paris. 1000 w. Comptes Rendus—June 27, 1904. No. 63921 D.

The Rochefort System of Wireless Telegraphy. A. Frederick Collins. Illustrated detailed description. 2500 w. Elec Wld & Engr—July 16, 1904. No. 63842.

The Spark System of the Wireless Telegraph Company (Das System Telefunken der Gesellschaft für Drahtlose Telegraphie). H. Pfitzner. A description of the improved apparatus of the company controlling the united Slaby-Arco and Braun Systems. 5000 w. Elektrotech Zeitschr—June 23, 1904. No. 63956 B.

Telephony.

Storage Battery Records in Telephone Practice. Howard S. Knowlton. Gives an example of weekly battery record, showing its advantages. 1200 w. Elec Wld & Engr—July 23, 1904. No. 64045.

The Telephone in the United States. Herbert Laws Webb. On the extensive development of the service the methods, rates, with review of the progress. 6000 w. Cassier's Mag—July, 1904. No. 63869 B.

DISTRIBUTION.

Conductors.

Aluminum Electrical Conductors. Roderick J. Parke. Abstract of a paper before the Can. Elec. Assn. States the advantages and disadvantages of aluminum, discussing joints, sag, &c. 3300 w. Elec Rev, N. Y.—July 2, 1904. No. 63715.

Aluminum Electrical Conductors. Roderick J. Parke. Summary of a paper before the Can. Elec Assn. Reviews the advantages and disadvantages of aluminum. 4900 w. Can Engr—July, 1904. No. 63852.

Converters.

Operation of Synchronous Converters. S. C. Lindsay. History of the experience with 60-cycle synchronous converters in Seattle during the last three years and a half. 2500 w. Trans Am Inst of Elec Engrs—June, 1904. No. 64111 D.

Earthing.

Earthing Arrangements and Leakage Indicating Devices. Considers every-day practice, particularly in connection with three-wire distribution systems. 1300 w. Elec Engr, Lond—July 8, 1904. No. 63888 A.

Fuse Plugs.

Supplement to the Report of the Commission on Standard Fuse Plugs with Edison Screw Threads (Erläuterungen zu den Vorschlägen der Kommission für Installationsmaterial). W. Klement. An explanation of the proposed standard fuse plugs to fit Edison lamp sockets. 3000 w. Elektrotech Zeitschr—June 16, 1904. No. 63954 B.

Polyphase Circuits.

On Pressure Variations in Polyphase Circuits. W. R. Kelsey. On the maintenance of balance with interconnected two-phase and with three-phase systems. 1600 w. Elec Engr, Lond—June 24, 1904. No. 63644 A.

Sub-Stations.

Polyphase Sub-Stations: Their Equipment and Working. S. L. Pearce. Deals with various types of sub-station equipments, considering some practical points which have arisen in connection with their working. 5400 w. Elec Engr, Lond—July 8, 1904. Serial. 1st part. No. 63887 A.

Switchboard.

See Electrical Engineering, Generating Stations.

Three-Wire.

A Three-Wire, 500-Volt Lighting System. Walter I. Barnes. Abstract of a paper read before the Boston convention of the Nat. Elec. Lgt. Assn. Describes the installation of the Narragansett Electric Lighting Company. 2000 w. Am. Elect'n—July, 1904. No. 63678.

Wiring.

Some Actual Results Obtained During the Use of Various Electric Wiring Systems. Discusses Metal tubing, wood casing, &c. 800 w. Elec Engr, Lond—July 15, 1904. No. 64084 A.

ELECTRO-CHEMISTRY.

Accumulators.

A Contribution to the Theory of the Jungner-Edison Accumulator with Constant Electrolyte. M. U. Schoop. An account of an investigation of the concentration changes and diffusion phenomena in the alkaline with constant electrolytic or "oxygen lifts cell." Also editorial. 7000 w. Elec Chem Ind—July, 1904. Serial. 1st part. No. 63734 C.

The Edison Storage Battery. An illustrated detailed description, stating the conditions Mr. Edison has aimed to fulfill. 5600 w. Engng—July 1, 1904. No. 63756 A.

The Origin and Development of Storage Batteries. E. B. Walker. Read before the Can. Elec. Assn. Reviews the history and considers those batteries which show

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improvements, or departure from standard practice; also diseases of batteries, applications, &c. 5000 w. Can Engr—July, 1904. No. 63851.

Alloys.

The Electrolytic Process of Refining Gold Alloys. Emil Wohlwill. States the conditions where the electrolytic process may be applied to part gold alloys, describing treatment, methods, &c., and the applications. 4000 w. Elec-Chem Ind—July, 1904. No. 63731 C.

Anodes.

Dimensions of the Films on Aluminum Anodes. William Roy Mott. Investigation of the thickness of the film. 3000 w. Elec-Chem Ind—July, 1904. No. 63733 C.

Convention.

The Bonn Meeting of the German Society of Electro-Chemists. John B. C. Kershaw. Brief review of the papers and discussions which attracted attention. 2500 w. Elec Rev, Lond—June 24, 1904. No. 63645 A.

Electric Smelting.

See Mining and Metallurgy, Iron and Steel.

Graphite.

Adaptability of Artificial Graphite Articles. C. L. Collins. Facts concerning what has been accomplished in regular commercial work, including figures covering exact costs. Ills. 2500 w. Elec-Chem Ind—July, 1904. No. 63735 C.

Laboratory.

The Electro-chemical Laboratory of the Massachusetts Institute of Technology. Prof. H. M. Goodwin. Illustrated description of the essential features of the equipment and arrangements. 2200 w. Elec-Chem Ind—July, 1904. No. 63732 C.

Methods.

Recent Electro-Chemical Methods. J. W. Richards. Notes progress in electro-metallurgy. 1000 w. Eng & Min Jour—July 21, 1904. No. 64028.

Tin Scrap.

Electrolytic Methods of Treating Tin Scrap. Gives details of all the processes which have attained industrial trial, with remarks upon costs. 3000 w. Engr, Lond—July 1, 1904. No. 63760 A.

ELECTRO-PHYSICS.

Ageing.

Experiments on the Ageing of Sheet Iron for Dynamos (Alterungsversuche an Dynamo blechen). J. Epstein, G. Stern, B. Soschinski. Tabulated results of experiments of several German manufacturers. 2000 w. Elektrotech Zeitschr—June 16, 1904. No. 63953 B.

Condensers.

High-Pressure Condensers (Ueber Hochspannungs-Kondensatoren). J. Moscicki. A long study of condenser construction for commercial purposes, with data and results of experiments on dielectrics, and upon the nature and extent of the losses. Two articles. 10000 w. Elektrotech Zeitschr—June 23, 30, 1904. No. 63957 each B.

Electrostatics.

The Electrostatic Capacity of Wires. George D. Shepardson. Considers the capacity in some of the more important cases of electrical conductors. 2200 w. Engrs' Soc, Univ of Minn—Year Book, 1904. No. 64106 D.

Radio-activity.

Atmospheric Radio-activity. H.. A. Bumstead. Describes experimental investigations. 3500 w. Am Jour of Sci—July, 1904. No. 63613 D.

The Theory of Electrons and Radio-activity (Elektrorientheorie und Radioaktivität). Dr. Clemens Schaefer. A discussion of the emanations of radioactive substances, and their influence upon the theories of physics and chemistry. 4000 w. Zeitschr d Ver Deutscher Ing—July 2, 1904. No. 63906 D.

GENERATING STATIONS.

Alternators.

Self-Exciting and Compounded Alternators. Gives illustrated particulars of recent machines of this class. 1500 w. Elect'n, Lond—July 15, 1904. No. 64086 A.

The Voltage Drop of Alternators. Dr. H. Behn-Eschenburg. Abstract translation from the *Elektrotechnische Zeitschrift*. Suggests a simple correction of a method in general use for the predetermination of alternator voltage drop. 1800 w. Elec Engr, Lond—June 24, 1904. No. 63643 A.

Deflection.

The Deflection of Dynamo Frames (Die Durchbiegung von Dynamogehaüsen). F. Niethammer. A brief examination of the effects of flexure of the shaft and frame of a dynamo upon the electrical conditions. 600 w. Zeitschr f Elektrotechnik—June 19, 1904. No. 63962 D.

Discussion.

Discussion on "Contribution to Theory of the Regulation of Alternators" and "The Mechanical Construction of Revolving-Field Alternators." The first paper was by H. M. Hobart and F. Punga; the second by David B. Rushmore. 5200 w. Trans Am Inst of Elec Engrs—June, 1904. No. 64109 D.

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Exposition.

The Westinghouse Power Plant at the St. Louis Exhibition. Illustrations of the fine electric-generating sets for supplying current needed in the Exhibition, with interesting particulars. 1700 w. Engng—July 15, 1904. No. 64092 A.

Hydro-Electric.

A Mexican Hydro-Electric Plant and Power Transmission. Robert McF. Doble. A well-illustrated account of the Guanajuato power station and the 100-mile, 60,000-volt transmission line. 4000 w. Engineering Magazine—August, 1904. No. 63973 B.

Hydro-Electric Power Development at and Near Joliet, Ill., Using Chicago Drainage Canal Water. Thomas T. Johnston. A discussion of the value of the water-power of this canal, the cost of development, &c. A criticism of this public work, with replies from Isham Randolph and G. M. Wisner. 12400 w. Jour W Soc of Engrs—June, 1904. No. 64142 D.

Hydro-Electric Power Installation in Iyo, Japan. Brief illustrated description. 900 w. Elec Wld & Engr—July 9, 1904. No. 63785.

The Catawba River Power Development Near Rock Hill, S. C. C. A. Mees. Illustrated detailed description of this recently completed plant. 2800 w. Eng Rec—July 23, 1904. Serial. 1st part. No. 64055.

The Hydro-Electric Power Development on the Catawba River, Near Rock Hill, S. C. Illustrates and describes one of the most interesting and complete hydro-electric developments in the South, installed to supply power within a radius of 18 miles. 2000 w. Elec Wld & Engr—July 23, 1904. No. 64043.

The Kern River Company's Hydro-Electric Power Enterprise. Burr Bassell. Brief illustrated description of a large power plant in California, the power to be transmitted 120 miles to Los Angeles. 900 w. Eng News—July 21, 1904. No. 64034.

Niagara.

The Toronto and Niagara Power Development. K. L. Aitken. Read before the Can. Elec. Assn. A detailed description of this power plant and its construction. 3800 w. Can Engr—July, 1904. No. 63855.

The Utilization of Niagara Power. H. W. Buck. An outline of the present status of the Niagara Falls Power Co. system, giving illustrated descriptions of the plants, and reporting the principal applications made of the power generated. 3500 w. Jour Assn of Engng Socs—June, 1904. No. 64134 C.

Paris.

A Large Parisian Electric Generating Plant. Francis Paul. Illustrated detailed description of the Moulineaux power station in Paris. 2500 w. Am Elect'n—July, 1904. No. 63676.

Switchboard.

The Larks Switchboard at the St. Louis Exposition. Illustrated description. 1000 w. Elec Wld & Engr—July 2, 1904. No. 63696.

Tariffs.

The Tariff Question Again (Nochmals die Tariffrage). Dr. Rasch. A discussion of the proper division of the charges for electricity supply. 2000 w. Elektrotech Zeitschr—June 23, 1904. No. 63958 B.

Transformers.

Iron Losses in Loaded Transformers. Dr. E. S. Johonnott. Offers an explantaion of the apparent diminution in the iron losses with increased load in the secondary. Also determines the magnitude of the exciting current and its phase with reference to the induction. Diagrams. 3500 w. Elec Wld & Engr—July 2, 1904. No. 63694.

On the Parallel Working of Delta- and Star-Connected Three-Phase Transformers. A. E. Kennelly and S. E. Whiting. Shows that it is not possible to parallel the secondaries of three-phase transformers when the transformation is delta-to-star or star-to-delta in one set, and delta-to-delta or star-to-star in the other. A study of phase transformation. 1200 w. Elec Wld & Engr—July 9, 1904. No. 63786.

Two-Phase.

The New Two-Phase Station at Sheffield. Illustrated description, the arrangement of the boilers and their furnaces, a regenerative system of induced draught, being of special interest. 3500 w. Elect'n, Lond—July 8, 1904. No. 63889 A.

See also Street and Electric Railways.

LIGHTING.

Arcs.

A. C. *vs.* D. C. Arc Systems. W. L. McFarlane. Read before the Can. Elec. Assn. Considers the relative costs and advantages of the different systems. 4800 w. Can Elec News—July, 1904. No. 64016.

The Bremer Light (Bremer Licht). Ernst Wagmüller. A description of the Bremer arc light, in which the carbons are impregnated with metallic salts, and arranged in an inclined position, the arc being formed below. 1800 w. Zeitschr d Ver Deutscher Ing—July 2, 1904. No. 63908 D.

Lamps.

Life of Incandescent Lamps. C. A. B. Garrett. Discusses results obtained in a

series of tests under ordinary working conditions. 1200 w. Elec Engr, Lond—July 1, 1904. No. 63745 A.

The Manufacture of Incandescent Lamps at the World's Fair, St. Louis. Illustrated description of this interesting exhibit. 2200 w. Elec Rev, N. Y.—July 23, 1904. No. 64046.

MEASUREMENT.

Electrical Measurement.

Electrical Measurements at the National Bureau of Standards. Morton Githens Lloyd. A detailed account of the work of this bureau. Ills. 9700 w. Pro Engrs' Soc of W Penn—Oct., 1903. No. 63865 D.

Insulation.

The Measurement of Insulation by Means of the Electrostatic Voltmeter (Isolationsmessung mittels des Elektrostatischen Voltmeters). Dr. J. Sahulka. Describing the application of the Siemens electrostatic method to the measurement of the insulation resistance of long cables. 2500 w. Elektrotech Zeitschr—June 30, 1904. No. 63959 B.

Meter Department.

The Organization and Management of a Central Station Meter Department. A. J. Cridge. Outlines some of the methods adopted in the equipment, maintenance and working of a meter department in connection with an electricity supply undertaking. Also discussion. 7000 w. Elec Engr. July 8, 1904. No. 63886 A.

Meter Rates.

A Proposed Method of Determining Meter Rates for the Sale of Current, with an Example from Data of a Large Steam-Driven Plant. A. M. Hunt. Read before the Pacific Coast Elec. Trans. Assn. Explains a system worked out by the writer. 1200 w. Jour of Elec—July, 1904. No. 64063 C.

Testing.

Loading Machines for Testing Purposes—Supplying Only the Losses. E. A. Regestein. Applies this method of getting full-load conditions on two direct-current machines, and two similar rotary converters. 3000 w. Elec Rev, N. Y.—July 9, 1904. No. 63787.

Some Notes on Testing. Describes some simple tests of dynamos and motors. 1200 w. Elec Engr, Lond—July 8, 1904. No. 63885 A.

Vectors.

On the Complex Product of Electromotive Force Current, and Other Vectors. Henry T. Eddy. On the multiplication of vectors, showing the differences between arithmetical and vector multiplication of two complex factors. 4000 w. Elec Wld & Engr—July 23, 1904. No. 64044.

Voltage.

Voltage Drop in Three-Phase Systems. W. W. Wood. Gives a quick method of calculating the voltage drop in three-phase conductors, applicable whether the system is star or mesh connected. 500 w. Elec Engr—July 15, 1904. No. 64082 A.

Voltmeters.

Standardizing the Voltmeter. George T. Hanchett. Describes an arrangement of instruments, and method of determining the accuracy of a station voltmeter at small cost. 1300 w. Cent Sta—July, 1904. No. 63790.

MOTORS.

Magnets.

Long Stroke Electro-Magnets for Industrial Purposes (Electro-Aimants Industriels à Longue Course). R. Bérard. Describing various forms of electro-magnets and solenoids suitable for actuating signals, and operating brakes, etc. 5000 w. Mem Soc Ing Civ de France—Feb., 1904. No. 63935 G.

Motor Diagrams.

Practical Applications of the Circle Diagram to the Induction Motor (Anleitung zum Praktischen Gebrauch des den Primären Spannungs und Stromverlust Berücksichtigenden Diagramms des Drehstrommotors). Friedrich Besig. Solutions of practical problems by use of the Heyland diagram. 3000 w. Zeitschr f Elektrotechnik—July 10, 1904. No. 63965 D.

The Induction Motor Diagram. W. Parker. Diagram with description, which shows not only the phases and magnitudes of the rotor and stator currents, but also the various fluxes operating in the motor. 1600 w. Elec Rev, Lond—July 1, 1904. No. 63749 A.

Regulation.

Pole Changing in Induction Motors (Polumschaltung von Drehstrommotoren). J. K. Sumec. An examination of the method of regulating the rotative speed of induction motors by varying the magnetic field. 2500 w. Zeitschr f Elektrotechnik—June 26, 1904. No. 63964 D.

Repulsion Motors.

The Inverted Repulsion Motor. Karl Faber. An analytical and graphical study of a repulsion motor in which the rotor is connected to line and the stator short circuited. 1500 w. Elec Wld & Engr—July 16, 1904. No. 63841.

Single-Phase.

Single-Phase Power Motors for Electric-Lighting Stations. W. A. Layman. Gives the writer's views as to the proper form of alternating-current equipment for large and small plants, comparing the cost

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of single and polyphase motors, and discussing related matter. 3500 w. Cent Sta—July, 1904. No. 63791.

Sparking.

Discussion on "Predetermination of Sparking in Direct Current Machines" and on the "Effect of Self-Induction on Railway-Motor Commutation." The first paper was by W. L. Waters; the second by E. H. Anderson. 10800 w. Trans Am Inst of Elec Engrs—June, 1904. No. 64110 D.

Starting.

Motor Starting Switches and Resistances. F. O. Hunt. Abstract of a paper read before the Birmingham Local Sec. of the Inst. of Elec. Engrs., with discussion. Discusses quantities affecting the working of the starter, and the lasting capabilities of the switch. 2500 w. Elect'n, Lond—July 15, 1904. No. 64087 A.

TRANSMISSION.

Cables.

The Breaking Down Strength of Cables (Die Durchschlagspannung von Kabeln). Dr. Hubert Kath. An examination of the electrical pressures required to break down the insulation of cables, showing the influence of the length of the cable. 5000 w. Elektrotech Zeitschr—July 7, 1904. No. 63961 B.

Economy.

Transmission of Power versus Shipment of Fuel. A. J. Bowie, Jr. Read before the Pacific Coast Elec. Trans. Assn. Gives figures on the relative values of the two plans for a large power transmission scheme. 1000 w. Jour of Elec—July, 1904. No. 64064 C.

Lines.

Medium-Span Line Construction. Clem. A. Copeland. Read before the Pacific Coast Elec. Trans. Assn. Discusses line construction, giving experience with various cables, and stating the importance of studying carefully the conditions. Ills. 3500 w. Jour of Elec—July, 1904. No. 64066 C.

Peru.

A Peruvian High-Voltage Transmission Plant. A. L. Kenyon. Brief illustrated description of the highest voltage long-distance transmission plant in South America. 1000 w. Elec Wld & Engr—July 2, 1904. No. 63693.

Regulator.

The Regulation of Transmission Lines. J. A. Lighthipe. Read before the Pacific Coast Elec. Trans. Assn. Illustrates and describes the Tirrill regulator and its working, and the Bristol recording device. 1100 w. Jour of Elec—July, 1904. No. 64067 C.

Single Phase.

Possibilities of Single-Phase Currents in Electric Power Transmission. H. A. Bullard and Sidney Sprout. Read before the Pacific Coast Elec. Trans. Assn. Shows various advantages in favor of single-phase transmission. 3000 w. Jour of Elec—July, 1904. No. 64065 C.

MISCELLANY.

Applications.

Some Recent Applications of Electricity on a Small Scale. Howard S. Knowlton. Describes its use in the photographic dark room, in exploring lights, electric bells on cars, and numerous other fields. 1800 w. Elec, N. Y.—July 6, 1904. No. 63619.

Education.

The Electrotechnical Institute at Vienna (Das Neue Elektrotechnische Institut in Wien). A general description of the establishment and its electrical equipment. 6000 w. Elektrotech Zeitschr—June 16, 1904. No. 63955 B.

GAS WORKS ENGINEERING

Burners.

A New Burner with Forced Draught. A. Lecomte. Read at meeting of the Société Technique. Explains method adopted for increasing the light of the mantle, describing the new lamp, and claiming this new type effects an economy of from 35 to 50 per cent. as compared with ordinary incandescent burners. 1800 w. Jour Gas Lgt—June 21, 1904. No. 63752 A.

I. An Incandescent Burner (for Warm Air) Which Can Be Easily Cleaned. M. Jouanne. II. An Inverted Incandescent Burner. M. Sellié. Abstract translations of two papers presented at the Congress of the Société Technique du Gaz en France, with illustrations. 500 w. Jour Gas Lgt—June 28, 1904. No. 63742 A.

Candle-power.

Low Candle-Power Gas. William Henry White. Read before the Western Gas Assn. Urging a cheaper gas of good heat value, good burners, and good men for the advancement of the gas industry. General discussion. 7000 w. Pro Age—July 1, 1904. No. 63710.

Charging.

An Elevating-Charging Machine. M.

We supply copies of these articles. See page 1037.

Passy. Read at meeting of the Société Technique. Illustrates and describes a new retort charger. 1100 w. Jour Gas Lgt—June 28, 1904. No. 63740 A.

Centrifugal Retort Chargers. F. H. Shelton. Describes various types of centrifugal coal projectors, and their advantages for charging coal-gas retorts. General discussion. Ill. 3000 w. Pro Age—July 1, 1904. No. 63711.

Charging-Machines at Villeurbanne (Lyons) Gas-Works. M. Boutan. Read at meeting of the Société Technique. Describes a plant worked electrically. The charge of coal is made into a sort of cartridge by enclosing it in a rigid tube, easily worked. 2200 w. Jour Gas Lgt—June 28, 1904. No. 63741 A.

Claus Plants.

Studies on the Claus Reaction. Gives results of investigations made, describing Claus plants tested in various works, and the tests made, stating results. 4000 w. Jour Gas Lgt—July 12, 1904. No. 64008 A.

Condensation.

Condensation of Solid and Liquid Particles in Suspension in Gases, Particularly in Lighting Gas. M. J. Philippard. Abstract of a paper read at meeting of the Société Technique de l'Industrie du Gaz en France. Discusses the deposition of dust in a gas, and the use of the "Cyclone" dust separator. Ills. 3800 w. Gas Wld—June 25, 1904. No. 63641 A.

Gas-Washer.

Theisen's Centrifugal Gas-Washer. Illustrates this machine, explaining the working principle of the system. 800 w. Engng—July 15, 1904. No. 64090 A.

Gas-Works.

The New Gas-Works at Nanterre, Near Paris. An illustrated detailed description. 5000 w. Jour Gas Lgt—July 12, 1904. No. 64005 A.

Hanover.

Hanover Gas-Works. An illustrated description of some of the chief features. 2800 w. Gas Wld—June 25, 1904. No. 63640 A.

The Growth of a Continental Gas-Works, Hanover. Illustrated historical sketch of this gas undertaking; also particulars about the new stoking machinery under trial. Ills. 6800 w. Jour Gas Lgt—June 28, 1904. No. 63739 A.

Illumination.

Light Measurement. Jacques Abady. A lecture delivered before the Dutch Assn. of Gas Mgrs. Hints on commercial light-testing. 5000 w. Jour Gas Lgt—July 12, 1904. No. 64007 A.

Inspection.

Gas Inspection. Ira C. Copley. Read at St. Louis meeting of Am. Gas Assn. Discusses state inspection to determine the quality and the testing of meters to assure the exact measurement, &c. 9000 w. Pro Age—July 15, 1904. No. 63805.

Management.

Notes on the Management of Gas-Works. George Helps. Discusses principally accounts and how to keep them, in the present article. 4400 w. Gas Wld—July 2, 1904. Serial. 1st part. No. 63738 A.

Photometry.

Some French Views on Photometry and Pyrometry. Abstract translations of several papers presented at a recent meeting of the Société Technique du Gaz en France. Ills. 2200 w. Jour Gas Lgt—July 5, 1904. No. 63764 A.

Progress.

Opening Address before the American Gas Associations, at St. Louis, Mo. Rollin Norris. Indicates lines along which progress is possible, such as cheaper raw materials, increased efficiency, reduced waste, &c. Brief discussion. 6000 w. Pro Age—July 15, 1904. No. 63803.

Purification.

Removing Suspended Particles from Gases. Principal portions of a paper by M. Philippard read at meeting of the Société Technique. Discusses briefly the principles of purification, investigating different types of condensers, and favoring the cyclone. 3500 w. Jour Gas Lgt—June 21, 1904. No. 63754 A.

Regulator.

The Luchaire-Lecomte Gas Regulator. M. Lecomte. Read before the Soc. Tech. du Gaz en France. Illustrates and describes a new device for regulating the consumption of gas. 1200 w. Jour Gas Lgt—July 12, 1904. No. 64006 A.

Retorts.

A Derval Setting of Retorts at the Nanterre Gas-Works. P. Parsy. Read before the Société Technique. An illustrated description of these inclined retorts and their working, explaining the simple remedy adopted to stop slipping in the retorts during carbonization. 2000 w. Jour Gas Lgt—June 21, 1904. No. 63753 A.

The Woodall-Duckham Vertical Retort. Illustrations and information from the patent specifications. 1500 w. Jour Gas Lgt—July 5, 1904. No. 63763 A.

Water Gas.

Introduction of Water Gas into Retorts in which Coal is Undergoing Carbonization. Abstract translation of a paper by Albrecht and Shirk Boyer, in *Jour. für Gasbeleuchtung.* Describes experiments made. 1700 w. Jour Gas Lgt—June 28, 1904. Serial. 1st part. No. 63743.

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INDUSTRIAL ECONOMY

Costs.

Some Conditions Affecting the Costs of Manufacturing (Einige Erwägung in der Frage der Selbstkostenbestimmung). S. St. Recsei. Deriving formulas and diagrams for use in determining the costs in the manufacture of dynamos. 3500 w. Zeitschr f Elektrotechnik—June 19, 1904. No. 63963 D.

Labor.

Payment of Labor. John Magee. A brief survey of the methods used, classifying them in nine groups and considering each. 2700 w. Am Found Assn—June, 1904. No. 63590.

The Labor Question. F. H. Shelton. Read at the St. Louis meeting of the Am. Gas Assns. Discusses the subject of improvement of the relations between gas companies and their employees, reviewing what has been done in the United States and offering suggestions. Discussion. 11000 w. Pro Age—July 15, 1904. No. 63804.

Patents.

The New Patent Law. A discussion of the British Patents Act of 1902, which attempts to give inventors the benefit of an official search, and to avoid the defects of other countries. 1700 w. Engr, Lond—July 1, 1904. No. 63758 A.

Piece System.

Notes on a Successful Piece Price System. John Magee. Outlines what has proved a successful way of handling the problem in a large foundry. 800 w. Am Found Assn—June, 1904. No. 63591.

Selling.

The Organization of the Machinery Selling Department. Russel M. Seeds. A discussion of the modern methods of seeking and developing a market, considered as a department of works organization. 3000 w. Engineering Magazine—August, 1904. No. 63974 B.

Specifications.

The Influence of Specifications on Commercial Products. Review of the presidential address of Dr. Charles B. Dudley, to the American Society of Testing Materials. 2500 w. Eng Rec—July 9, 1904. No. 63782.

Trade Expenditure.

The Supervision and Control of Trade Expenditure. Describes the working of a system now in use, showing that the methods adopted have not only effected economy, but have developed rather than curtailed the business. 2700 w. Engr, Lond—July 15, 1904. No. 64096 A.

Wages.

A Review of the Wage Problem. C. H. Benjamin. Outlines briefly the various systems that have been tried, discussing their merits. 5000 w. Cassier's Mag—July, 1904. No. 63871 B.

MARINE AND NAVAL ENGINEERING

Coal Endurance.

Methods of Estimating the Coal Endurance of a Naval Vessel. D. W. Taylor. Discusses the factors affecting coal consumption and considers the principal methods of obtaining approximate results. 5000 w. Eng News—July 14, 1904. No. 63837.

Coal Storage.

The Coal Storage and Coal Handling Plant at the New York Navy Yard. Jos. S. Shultz. Illustrates and describes a plant recently completed, giving information in regard to its construction and working. 3200 w. Eng News—July 21, 1904. No. 64040.

Destroyers.

Destroyers. Editorial discussion of the new torpedo-boat destroyers for the British government. 4000 w. Engng—July 8, 1904. No. 63893 A.

H. M. Torpedo-Boat Destroyer "Welland." Illustration, with brief description and report of official trials. 900 w. Engng—July 8, 1904. No. 63892 A.

Diving.

Notes on Diving Machinery (Considérations sur les Scaphandres). M. Dibos. A discussion of recent forms of diving suits and apparatus for wrecking, and for submarine work generally. 3500 w. Mem Soc Ing Civ de France—March, 1904. No. 63937 G.

Excursion Steamer.

Handsome Excursion Steamer. Illustrated description of the Old Colony, built for the Boston and Plymouth route. 1000 w. Naut Gaz—July 14, 1904. No. 63792.

Fire Protection.

Fire Protection for Steam Vessels and Government Regulations. J. H. Morrison. Reviews the fire equipment of

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steamboats from the earliest vessels. 1500 w. Sci Am Sup—July 16, 1904. No. 63808.

Fleets.

Steaming Powers of the Russian and Japanese Fleets. Gives interesting particulars in regard to the vessels of both fleets, their present condition, how they have fared, &c. 1500 w. Engr, Lond—July 15, 1904. No. 64100 A.

Liners.

Launch of the Cunard Liner Caronia. Two illustrations with detailed description of the largest ship thus far built on the Clyde. 2000 w. Engr, Lond—July 15, 1904. No. 64099 A.

The New Cunard Flyers. Albert G. Hood, in the Mid-Tyne Link. Brief review of the growth in size of vessels used to navigate the Atlantic. Diagrams. 2000 w. Marine Rev—July 28, 1904. No. 64159.

The New Cunard Liner "Caronia." Illustrated detailed description of this very large ship. 1800 w. Engng—July 15, 1904. No. 64095 A.

The New White Star Liner "Baltic"—the Largest Vessel in the World. Brief illustrated description, with account of the maiden trip. 1100 w. Sci Am—July 16, 1904. No. 63807.

Motor Boat.

Motor Boating. Illustrates and describes the powerful petrol racing launch being built for Lord Howard de Walden. 1200 w. Auto Jour—July 16, 1904. No. 64078 A.

Remarkable Naphtha Boat John Chamberlin. Brief description, with illustrations, of a novel experimental boat. 700 w. Marine Rev—July 21, 1904. No. 64041.

Some Experiments on an Uncooled Petrol Motor. L. H. Callendar. Summary of experiments made to test these motors, describing methods and apparatus used. 7000 w. Sci Am Sup—July 30, 1904. No. 64157.

Navy Yard.

Electricity at the Washington Navy Yard. J. E. Price. An illustrated article giving information of the electric outfitting of the various shops. 1100 w. Elec Rev, N. Y.—July 16, 1904. No. 63839.

Revenue Cutter.

Trial of the United States Revenue Cutter Mohawk. Description of the vessel and its equipment, with report of the contract trial. 1800 w. Marine Engng—July, 1904. No. 63622 C.

Torpedo Boat.

A Turbine-Driven Torpedo-Boat. Reports an unofficial trial of a boat built by Messrs. Yarrow & Co., describing the vessel and its equipment. 700 w. Engng—July 15, 1904. No. 64094 A.

Torpedo Tubes.

The Submarine Torpedo Tube. Illustrates and describes a torpedo-tube of the type used on the battleship "Maine," the room below the protective deck, and the operation of firing. 1200 w. Sci Am—July 9, 1904. No. 63728.

Warships.

Progress of Warships and Machinery Building in England. A record of the work in these fields during the last half year. 2500 w. Engr, Lond—July 8, 1904. No. 63896 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Benz.

The Possibilities of the Belt-Driven Benz. R. W. Buttemer. Illustrates and describes some improvements made in these cars. 2000 w. Autocar—July 2, 1904. No. 63737 A.

Carburetter.

See Mechanical Engineering, Internal-Combustion Motors.

Gasoline Car.

Design for a Light Gasoline Car. J. C. Brocksmith. Working drawings and description of a gasoline automobile of light and simple construction. 2700 w. Am Elect'n—July, 1904. No. 63679.

Holson Motor.

A New Four-Wheel Drive Freight Truck. Corneil Ridderhof. An illustrated description of a vehicle equipped with the Holson couple-gear motor. 800 w. Mach, N. Y.—July, 1904. No. 63690 C.

Hutton.

The Hutton Car. Description, drawings and illustrations of a car aiming to bring the least possible strain upon the driver, enabling concentration on the steering-wheel. 3600 w. Engng—June 24, 1904. No. 63648 A.

Light Cars.

The Clement-Talbot Cars. Illustrated description of these light cars, remarkable for their silence and ease of control,

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great flexibility of engine and power in proportion to weight. 1200 w. Autocar —July 2, 1904. No. 63736 A.

Mercedes.

The Latest Mercedes Model—The 28-32 H. P. Car. Illustrations and particulars of this type, showing the improvements in design. 2500 w. Auto Jour—July 9, 1904. No. 63880 A.

Motive Power.

Motive Power for Automobiles. Prof. R. C. Carpenter. From a paper read before the Am. Motor League, in New York. Reviews briefly the motive power at present used, considering the gas engine the most economical and convenient means of propulsion. 2200 w. Automobile—July 23, 1904. No. 64042.

Motor Cars.

Motor Cars on European Railways. Illustrates and describes some of the recent motor cars and motor-car services of European railways. 6800 w. Eng News—July 28, 1904. No. 64150.

Mountain Trip.

3,000 Kilometres by Motor Car Over the Alps. An illustrated account of an interesting trip made in a Martini car. 2800 w. Auto Jour—July 16, 1904. No. 64077 A.

Pumps.

Water Circulating Pumps. F. Strickland. Describes the types used at different times in automobiles, suggesting improvements. Ills. 1000 w. Autocar—June 25, 1904. No. 63634 A.

Road Trains.

Automobile Road Trains. Daniel Bellet. Illustrations and brief description of trains devised by Col. Charles Renard. 900 w. Trac & Trans—July, 1904. No. 64004 E.

Tyres.

Remarkable Tyre-Bursting Demonstration. An account of an interesting demonstration given by S. E. Edge at the Crystal Palace to show that bursting tyres are not as disastrous as claimed. Ills. 700 w. Autocar—July 16, 1904. No. 64075 A.

Variable Gears.

The "Hall" Hydraulic Variable Speed-Gear. Illustrated description of a form of gear in which a hydraulic system, using oil as the fluid medium, is employed. 3300 w. Auto Jour—June 25, 1904. Serial. 1st part. No. 63633 A.

HEATING AND COOLING.

Hot Water.

A Central Hot-Water Heating Plant in the Boston Navy Yard. Describes an installation of the Evans exhaust hot-water heating system with forced circulation, and its working. Ills. 4500 w. Eng Rec —July 16, 1904. No. 63847.

Ventilation.

Notes on the Plenum System of Ventilation. William Henman. Also discussion. Showing that this system can be beneficially employed in certain buildings. 16000 w. Jour Roy Inst of Brit Archts—June 11, 1904. No. 63612 B.

Warm Air.

Advanced Methods of Warm Air Heating. A. C. Jones. Read before the Am. Soc. of Heat. & Ven. Engrs. Illustrates and describes a system, giving a plan of a residence which is heated with a warm air furnace, where seven supply pipes are used for heating thirteen rooms. 1800 w. Met Work—July 16, 1904. No. 63789.

HYDRAULICS.

Air Lifts.

Air-Lift Pumping Plant at Birkenhead. J. W. M. Richardson. Abstract of a paper read before the British Assn. of Water-Works Engrs. and of the discussion thereon. Describes a plant put down to increase the water supply, giving particulars of the cost of working. 4200 w. Jour of Gas Lgt—July 19, 1904. No. 64138 A.

Raising Water by Compressed Air. C. T. Alfred Hanssen. Explains the theory of the air-lift pump, the conditions of maximum efficiency, &c. Ills. 4000 w. Engng Rev—July, 1904. No. 64014 B.

Centrifugal Pumps.

High-Lift Turbine Pumps. Illustrates and describes an electrically driven pump of this type, of very good efficiency. 900 w. Engng—June 24, 1904. No. 63649 A.

High-Pressure Centrifugal Pumps (Hochdruck Kreiselpumpen). H. Dubbel. Illustrating and describing centrifugal pumps arranged to operate in series at high rotative speeds to pump against heads of several hundred metres. 2000 w. Zeitschr de Ver Deutscher Ing—July 2, 1904. No. 63907 D.

High-Pressure Centrifugal Pumps (Pompe Centrifuge à Haute Pression). K. Sosnowski. A description of the de Laval system, using small runners connected directly to a steam turbine. 2500 w. Mem Soc Ing Civ de France—Feb., 1904. No. 63936 G.

The Rateau High Pressure Centrifugal Pumps and Blowers (Hochdruck Kreiselpumpen und Hochdruckventilatoren System A. Rateau). Julius Divis. Describing the series arrangement of runners designed for direct connection to the steam turbine for pumping or blowing against high pressures. Three articles. 1 plate. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 25, July 2, 9, 1904. No. 63943 each D.

We supply copies of these articles. See page 1037.

High Pressure.

High Pressure Hydraulic Distribution of Power with Special Reference to Elevator Machinery. H. D. James. Presents the advantages of water power at high pressure, its applications, &c., discussing its advantages and disadvantages as a power for elevators. General discussion. 7000 w. Pro Engrs Soc of W Penn—April, 1904. No. 64131 D.

Pumping Engines.

Pumping Engines at Hinksford. Illustrated description of these engines with results of official tests. 1800 w. Engr, Lond—July 8, 1904. No. 63898 A.

Working Costs of Water-Works Pumping-Engines. A. H. Meysey-Thompson and H. Lupton. Abstract of a paper before the British Assn. of Water-Works Engrs., and of the discussion. Considers four main types of pumping-engine. 3000 w. Jour Gas Lgt—June 21, 1904. No. 63755 A.

Turbines.

The Reversibility of Hydraulic Turbines (Sur la Réversibilité des Turbo-Machines Hydrauliques). Platon Yankowsky. A study of turbine water-wheels and centrifugal pumps showing the manner in which they are related to each other. 12000 w. Revue de Mécanique—May 31, 1904. No. 63928 E + F.

Water-Power.

An Unusual Water-Power Plant at Kykkelsrud, Norway. Illustrates and describes the development of an unusually interesting water-power plant, comprising dams, an open canal, and a power house, the hydraulic works, &c. 3000 w. Eng Rec—July 2, 1904. No. 63662.

INTERNAL-COMBUSTION MOTORS.

Carburetter.

The Claudel Carburetter (Le Carburateur Claudel). H. Claudel. A study of the general theory of carburetting air with the vapor of liquid fuels for internal combustion motors, and a description of the author's apparatus. 4000 w. Mem Soc Ing Civ de France—March, 1904. No. 63938 G.

Combustion.

The Chemistry of Combustion. An explanation of the chemistry of the petrol engine. 1600 w. Autocar—July 9, 1904. No. 63878 A.

Diesel.

The Diesel Engine. W. H. Booth. An account of a commercial test made of a Diesel engine when driving electric generators. 2800 w. Engr, U S A—July 15, 1904. No. 63864 C.

Gas Engines.

The Bollinckx Gas Engine and Producer. A. H. Allen. Illustrates and describes particulars of a modern design of this engine. 1200 w. Engr, U S A—July 1, 1904. No. 63671 C.

Petrol Turbine.

A New Petrol Turbine. Illustrates and describes a design for an internal combustion turbine motor. 1000 w. Autocar—July 16, 1904. No. 64076 A.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

The Theory of Ball Bearings (Sur les Roulements à Billes). L. Lecornu. An examination of the formulas of Léauté and Bousshinesq, for computing the frictional resistance of ball bearings. 2000 w. Revue de Mécanique—May 31, 1904. No. 63929 E + F.

Belt Machine.

The Hyatt-Belt Fabric Stitching-Machine. Illustrated description of a machine for the making of belts, rugs, carpets, &c. Describes its action. 1600 w. Engng—July 15, 1904. No. 64091 A.

Castings.

Direct Casting from the Blast Furnace. An account of the revival of an old practice, with very considerable improvements, in Northamptonshire, by which a portion of the make of the furnaces is converted into castings, describing the arrangements. 1800 w. Engr, Lond—July 1, 1904. No. 63759 A.

Spongy Brass Castings. C. Vickers. Discusses the cause of the trouble. 2000 w. Am Mach—July 7, 1904. No. 63683.

Making Castings in Aluminum. Walter J. May. Calls attention to points that are of importance to ensure successful work. 1200 w. Prac Engr—July 15, 1904. No. 64079 A.

Cores.

A Plea for the Coremaker. Alex. T. Neil. Considers some of the troubles in core-making. Ills. 1000 w. Am Found Assn—June, 1904. No. 63593.

Core Making Machines (Kernformmaschinen). Oskar Leyde. Illustrating a number of machines, mainly of German design. 1500 w. Zeitschr d Ver Deutscher Ing—July 9, 1904. No. 63911 D.

The Core Bench. Benjamin D. Fuller. Discusses the essentials of good core work in the economical production of castings. 700 w. Am Found Assn—June, 1904. No. 63592.

Cranes.

Foreign Types of Steam and Electric Harbor Cranes. Frank C. Perkins. Illustrated detailed descriptions of electric cranes for dock work. 2300 w. Marine Engng—July, 1904. No. 63621 C.

The Electrical Equipment of Overhead

We supply copies of these articles. See page 1017.

Travelling Cranes. J. W. Warr. An illustrated description of a crane with separate motors for each motion, the wiring and fitting. 900 w. Elec Rev, Lond—July 15, 1904. No. 64085 A.

Cupolas.

Investigations of the Blowing of Foundry Cupolas. Abstract of a paper by W. H. Carrier, giving results of investigations made by the Buffalo Forge Co., with comments. 2500 w. Eng News—July 21, 1904. No. 64038.

Elevators.

The Works of the Standard Plunger Elevator Company. W. A. Waterman. Illustrated detailed description of these works, located at Worcester, Mass. Also details of the elevator manufactured. 3800 w. Mach, N. Y.—July, 1904. No. 63691 C.

Foundries.

Foundry Accounting. Kenneth Falconer. Describes a foundry "cost system" representing a part of a complete system designed for large brass works, with remarks on the subject in general. 1500 w. Am Found Assn—June, 1904. No. 63597.

Lincoln Plant of the United Engineering & Foundry Co., at Pittsburg. An illustrated description of one of the largest plants for the manufacture of rolls for the working of iron and steel. 2500 w. Ir Trd Rev—July 7, 1904. No. 63777.

Some Labor-Saving Suggestions for the Foundry. H. F. Frohman. Calls attention to devices found useful in the foundry. 1000 w. Am Found Assn—June, 1904. No. 63594.

The Iron Foundry of Bopp & Reuther at Waldhof, near Mannheim (Die Eisengiesserei der Firma Bopp & Reuther in Waldhof bei Mannheim). Illustrated description of a recent German foundry, arranged for electric driving and machine moulding. 2500 w. 1 plate. Stahl u Eisen—June 15, 1904. No. 63949 D.

Gauge.

Inspirator Valve Gauge. L. C. Hitchcock. Description and sketch of a gauge made in the shops of the Northern Pacific Ry. Co. 900 w. Loc Engng—July, 1904. No. 63723 C.

Green-Sand.

Standard and Systematic Methods for Making Beds. Thomas D. West. An illustrated article giving the results of the writer's experience and investigations in making green sand beds. 5000 w. Am Found Assn—June, 1904. No. 63598.

Grinder.

The Walker Tool Room Grinder No. 2. Illustrates and describes a tool intended for cutter-grinding, but also used for grinding miscellaneous work. 2200 w. Ir Age—June 28, 1904. No. 64148.

Jigs.

Jig Making. Frank E. Shailor. Discusses methods of accurately spacing the holes. Ills. 1800 w. Mach, N. Y.—July, 1904. No. 63692 C.

Laboratory.

The Value of the Chemist and Metallurgist to a Manufacturing Plant. H. C. Loudenbeck. On the value of a chemical laboratory with hints in regard to its practical application to the work. 1400 w. Am Found Assn—June, 1904. No. 63595.

Linkages.

The Generation of a Compound Curve by Three Double Linkages (Zur Erzeugung der Koppelkurve durch Drei Doppelkurbelgetriebe). Heinrich Kratzert. An examination of the kinematic theory of the three-bar linkage motion, and the curves generated by it. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 1, 1904. No. 63927 D.

Locomotives.

Industrial Locomotives. J. F. Gairns. The present article deals with steam locomotives mainly for mining or factory use. Ills. 3500 w. Cassier's Mag—July, 1904. Serial. 1st part. No. 63870 B.

Mechanical Drawing.

A Proposed Universal Dictionary of Mechanical Drawing. George H. Follows. The first of a series of articles aiming to furnish an acceptable "drawing dictionary." Ills. 1800 w. Eng News—July 14, 1904. Serial. 1st part. No. 63832.

Molding.

Machine Molding. G. P. Campbell. The present article discusses flasks. Ills. 1800 w. Am Mach—July 28, 1904. Serial. 1st part. No. 64147.

Molding Machines and Their Use. E. H. Mumford. Abridged paper, read before the Am. Found. Assn. Remarks on some of the simpler machines. 1200 w. Am Mach—July 7, 1904. No. 63682.

Molding Machine Practice. Fred W. Hall. An illustrated article treating of the match plate method of machine molding. 2200 w. Foundry—July, 1904. No. 63632.

Patternmaking.

Patternmaking in Its Relation to Foundry Costs. W. H. Parry. Considers some of the shortcomings incident to the making of patterns. 900 w. Am Found Assn—June, 1904. No. 63596.

Patterns.

A Water Tank Column Pattern. Joseph Horner. Illustrated description.

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1100 w. Am Mach—July 21, 1904. No. 64026.

System for Storing and Caring for Patterns. R. S. Chemin. Briefly considers the handling and shipping, accounting, indexing and storage of patterns. 1400 w. Am Mach—July 14, 1904. No. 63793.

Phonograph Works.

The Edison Phonograph Works, Orange, New Jersey. Remarks on the Edison phonograph display at St. Louis, and plan and description of the factory. 5500 w. Engng—June 24, 1904. No. 63647 A.

Pistons.

Making Gas-Engine Pistons. R. F. Garland. Illustrates and describes tools and methods for this work. 2400 w. Am Mach—July 14. 1904. No. 63794.

Projectiles.

High-Speed Steel and the Manufacture of Armor-Piercing Projectiles. Illustrates and describes the processes through which a shell passes in manufacture. 1700 w. Am Mach—July 7, 1904. No. 63681.

Riveting.

Electric vs. Hydraulic Cranes for Riveter Towers. Frank B. Kleinhans. Claims the electric crane to possess advantages for this work. 1500 w. Elec Wld & Engr—July 2. 1904. No. 63695.

Shop Locomotives.

Storage Battery Locomotives for Shop Transportation. J. A. McIntyre. Illustrated descriptions of exhibits at the Louisiana Purchase Exposition. 700 w. Sci Am Sup—July 16, 1904. No. 63809.

Springs.

On the Transverse Vibrations of Helical Springs. Howard L. Bronson. A study of this subject, describing apparatus and methods of investigation, giving results. 3000 w. Am Jour of Sci—July, 1904. No. 63614 D.

Tool Rooms.

The Tool Room and its Functions in Cost Reduction. John Ashford. Mr. Ashford's second paper treats of the standardizing of small tools and the study of operations in which they are used. 4500 w. Engineering Magazine—August, 1904. No. 63976 B.

Turret Lathes.

The Development of a Remarkable Turret Lathe. Illustrates and describes development of the "flat turret" for imparting to the spindle a range of speeds and to the turret slide a wide feed variation. 2500 w. Am Mach—July 28, 1904. Serial. 1st part. No. 64146.

Works.

The Pennsylvania Engineering Works. Plan and description of large works devoted to the building of blast furnace and steel plant construction, general machine and plate work, ingot molds and heavy castings. 2200 w. Ir Age—July 7, 1904. No. 63684.

MATERIALS OF CONSTRUCTION.

Carborundum.

Carborundum Firesand. T. J. Tone. On its special properties and the applications. 1200 w. Ir Trd Rev—July 21, 1904. No. 64019.

Cast-Iron.

Notes and Observations on Cast-Iron. J. E. Johnson, Jr. Considers especially the production of satisfactory castings from iron considered unsuitable by the average foundryman, giving much information of value. 4500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 64123.

The Mobility of Molecules of Cast-Iron. A. E. Outerbridge, Jr. Gives some further investigations on the behavior of cast iron, and calls attention to the effects of the Baltimore fire on this material. 1500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 64144.

Corrosion.

A New Process for the Protection of Iron and Steel from Corrosion. Sherard Cowper-Coles. Describes a new process of coating iron and steel with a thin even deposit of zinc at a temperature several hundreds of degrees below the melting point of zinc. 1800 w. Prac Engr—July 1, 1904. Serial. 1st part. No. 63744 A.

Ductility.

The Limit of Ductility (Zum Begriff "Streckgrenze"). C. Bach. A discussion of the need of a term to indicate the limit of ductility in testing materials, and a suggestion as to its correct definition and determination. 1800 w. Zeitschr d Ver Deutscher Ing—July 9, 1904. No. 63912 D.

Laboratory.

The Royal Testing Laboratory at Gross-Lichterfelde-West (Das Königliche Materialprüfungsamt zu Gross-Lichterfelde-West). An illustrated account of the new buildings to be occupied by the Royal testing laboratory and the Chemical-Technical Research Department of the Prussian Government, near Berlin. Serial. Part I. 4000 w. Zeitschr d Ver Deutscher Ing—July 9, 1904. No. 63909 D.

Lubricants.

Analyses of Lubricating Greases. P. H. Conradcon. Considers solid lubricants, and the mthods of analyzing them. 5000 w. Pro Engrs' Soc of W. Penn—March, 1904. No. 63867 D.

Mineral Lubricating Oils. J. N. Bruck. A lecture before the Engrs.' Assn. of Boston. Deals with the process of refining

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and testing mineral oils, and the characteristics of an efficient lubricator. 2500 w. Engr, U S A—July 1, 1904. No. 63672 C.

Metals.

The Hard and Soft States in Metals. G. T. Beilby. A study of metals, explaining a new phase theory, illustrating by examples, and giving a full account of researches. General discussion. Ills. 12000 w. Elec-Chem & Met—June, 1904. No. 64104 C.

Pig Iron.

Chemical Specifications for Pig-Iron. B. F. Fackenthal, Jr. A discussion of the paper by Edgar S. Cook. 1500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 64118.

Testing.

Testing Machine of 300 Tons Capacity (Machine Universelle d'Essais de 300 Tonnes). Pierre Breuil. An account of the large testing machine made by Buckton & Co., of Leeds, for the laboratory of the Conservatoire des Arts et Métiers. 2000 w. Génie Civil—July 2, 1904. No. 63915 D.

The Testing Laboratory of the Conservatoire des Arts Et Métiers (Le Laboratoire d'Essais du Conservatoire National des Arts et Métiers). E. Leduc. With views of the various departments and an outline of the system of work. Serial. Part I. 2000 w. Revue Technique—June 25, 1904. No. 63950 D.

MEASUREMENT.

Beams.

Problems in Beams and Planes Severally Supported and Eccentrically Loaded. C. F. Blake. Remarks on the principles of the polar moment of inertia method and its applications to these problems. 1200 w. Mach, N. Y.—July, 1904. No. 63689 C.

Diagrams.

A Diagram Measurer. Describes a cheap and useful instrument—explaining its use. 1100 w. Prac Engr—July 8, 1904. No. 63882 A.

Fly Wheels.

Graphic Method for Determining the Weight of Flywheels. Diagrams are given, with explanation. 800 w. Prac Engr—July 8, 1904. No. 63881 A.

Link Motion.

Link-Motion Bench for the Technical College, Finsbury. Illustration, with description of an apparatus designed by Prof. W. E. Dalby for investigating the properties of a link motion. 1000 w. Engng—July 8, 1904. No. 63891 A.

POWER AND TRANSMISSION.

Belts.

A New Rule for Belt Calculations. States rule, illustrating by examples. 2400 w. Elec Engr, Lond—July 1904. No. 64083 A.

Compressed Air.

A Novel Air Compressor. Brief illustrated description of the invention of Henry Bland, of Sydney, Australia. 800 w. Sci Am—June 16, 1904. No. 63806.

Comparison of Costs of Compressing Air with Steam and Electricity at Rossland, British Columbia. William Thompson. Describes the steam and electric plants compared, and records their performance. 2500 w. Min Rept—July 14, 1904. No. 63859.

Packing a Compressor Piston. T. R. Wingrove. Discusses the wrong way and the right way of packing a rod. 2200 w. Ice & Refrig—July, 1904. No. 63720 C.

The Air Compressor. R. H. Collingham. Discusses the design of air compressors with the object of indicating how theoretical facts and formulæ may be made of use in the drawing-office. 1400 w. Engr, Lond—June 3, 1904. Serial. 1st part. No. 63650 A.

The Compressed Air Power Transmission Plant of the Cleveland Stone Company. Lucius I. Wightman. An illustrated detailed description of a central power plant, transmitting power by air pipe lines to various machines throughout the quarry. 6500 w. Eng News—July 7, 1904. No. 63702.

Fly Wheels.

Belt-Wheel Explosion at Mishawaka, Ind. Ira C. Boles. An illustrated account of an unexplained accident on March 31, 1904. 700 w. Power—July, 1904. No. 63688 C.

Gears.

The Solution of Problems in Spiral Gearing. E. C. Oliver. Gives a simple and accurate method for the solution of any problem in spiral gearing. 1000 w. Engrs' Soc, Univ of Minn—Year Book, 1904. No. 64107 D.

Worm Gearing. F. L. Berry. Discusses this form of speed reducer, its advantages, and the cause of bad designs, considering the factors that influence the efficiency, &c. Ills. 3500 w. Mech Engr—July 16, 1904. No. 64080 A.

Heat Motors.

The Recent Development of Heat Motors (Ueberblick über die Gegenwärtige Entwickelung der Wärmemotoren und Kraftwerke). E. Josse. A general review of the development of steam and gas engines since the Paris exposition of 1900;

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including turbines and binary vapor engines. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—June 18, 25, 1904. No. 63900 each D.

Machinery.

Pumping and Air Compressing Machinery at the St. Louis Exposition. An illustrated review of exhibits showing the latest achievements in these and allied branches of engineering. 4000 w. Ir Age—July 21, 1904. Serial. 1st part. No. 64017.

Machinery Tests.

Some Tests of Iron and Woodworking Machinery. C. H. Hines. An account of tests made to determine the amount of power used by old machine tools in a shop which was to be equipped with electricity and yet retain the old machines. 3000 w. Elec Wld & Engr—July 16, 1904. No. 63843.

Mechanical Plant.

The Mechanical Plant of the Hotel Astor, New York City. An illustrated detailed description of the fine power and refrigerating plant in the latest great hotel of this city. 5200 w. Eng Rec—July 23, 1904. No. 64047.

Power Cost.

The Cost of Power in a Large Iron Works (Krafterzeugungskosten für ein Grosses Hüttenwerk). Karl Iffland. Giving an elaborate tabulation of the various elements of power cost for steam, gas, and electric driving. 10000 w. Stahl u Eisen—June 15, 1904. No. 63948 D.

Rope Driving.

Some Notes on Rope Driving. John Joseph Flather. Notes on the systems used, the materials, care, strains, speed, &c. Ills. 6000 w. Engrs' Soc, Univ of Minn—Year Book, 1904. No. 64108 D.

Speed-Varying.

Gasnier's New Electro-Mechanical Coupling and Speed-Varying Device. E. P. Buffet. Illustrates and describes an electro-mechanical method of transmission devised by Paul Gasnier. 1200 w. Am Mach—July 14, 1904. No. 63795.

STEAM ENGINEERING.

Boiler-House.

Boiler-House Economies. Abstract of a paper by Reginald S. Downe read at meeting of the Incor. Munic. Elec. Assn. Considers means of reducing the coal consumption. 4000 w. Mech Engr—July 16, 1904. No. 64081 A.

Boilers.

Butt Strap Joints for Boilers. R. S. Hale. Discusses the width and thickness of the straps. 700 w. Power—July, 1904. No. 63687 C.

Copper Tubes for Locomotive Boilers. Francis W. Webb. Abstract of a paper presented to the Inst. of Civ. Engrs., London. An account of experimental investigations made to ascertain the composition of the copper tubing most suitable for use in locomotive boilers. Ills. 1200 w. R R Gaz—July 15, 1904. No. 63797.

Ferry Works, Queensferry. An illustrated article describing details of the Niclausse boilers as manufactured at their new works. 2800 w. Engr, Lond—July 1, 1904. No. 63761 A.

Cooling Tower.

Cooling Tower and Condensing Equipment in an Atlanta Plant. Illustrations and description of a cooling tower installation designed to handle 260,000 gallons of water per hour, and a condensing equipment, including a beam-type quadruple expansion pump. 1700 w. Eng Rec—July 9, 1904. No. 63784.

Explosion.

Explosion of a Locomotive Boiler (Explosion d'Une Chaudière de Locomotive). P. Bardy. A description of a serious explosion of the boiler of a locomotive at the St. Lazare Station, at Paris. 1500 w. Génie Civil—July 9, 1904. No. 63918 D.

Exposition Plant.

The Steam Plant of the St. Louis Exposition. Remarks on the Exposition, with illustrated description of the power plant. 5000 w. Power—July, 1904. No. 63686 C.

Feed Water.

Foaming Waters and Scaling Waters for Locomotive Boilers. M. E. Wells. Considers boiler troubles due to the water used and the remedies. 2500 w. Eng News—July 21, 1904. No. 64036.

Governing.

The Governing of High-Speed Engines. J. H. Dales. Investigates the principles on which governing apparatus is constructed, discussing the several types of governor which are in general use. 2200 w. Engng Rev—July, 1904. Serial. 1st part. No. 64012 B.

Lubrication.

Lubrication of Steel Works and Blast Furnace Engines and Machinery. William M. Davis. Read before the Ohio Soc. of Mech., Elec. and Steam Engrs. Treats the subject from the engineer's point of view, considering efficient lubrication and cost. 2200 w. Engr, U S A—July 15, 1904. No. 63863 C.

Pumping Engines.

See Mech. Engineering, Hydraulics.

Safety Devices.

Water Columns and Low-Water Alarms. R. T. Strohm. Illustrates and describes

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various forms of these devices, and shows the advantages to be derived from the use of a good water alarm. 2700 w. Am Elect'n—July, 1904. No. 63680.

Steam.

A Study of Steam Generation (Etude sur la Production de la Vapeur). A. Lencauchez. An examination of the principles involved in steam generation, and a discussion of the extent to which they are realized in existing steam boilers. 1200 w. 3 plates. Mem Soc Ing Civ de France—March, 1904. No. 63939 G.

Steam Engines.

Engines of H. M. S. Prince of Wales. Illustrations, with brief description. 500 w. Engr, Lond—July 1, 1904. No. 63762 A.

Portable Steam Engines of To-Day. J. C. R. Adams. The present article discussses some of the theoretical considerations which have played an important part in the development. Ills. 2700 w. Page's Mag.—July, 1904. Serial. 1st part. No. 64011 B.

Tod Rolling Mill Engines. Illustrates and describes modern engines built at Youngstown, Ohio. 3400 w. Ir Age—July 28, 1904. No. 64149.

Steam Plants.

The Choice of a Steam Plant, with Special Reference to American Electric Power Installation. George H. Barrus. Briefly considers steam turbines, the choosing of a reciprocating engine, the selection of boilers, &c. 3000 w. Cassier's Mag—July, 1904. No. 63872 B.

Steam Turbines.

The Curtis Steam Turbine. Frank C. Smallpiece. From a paper before the Can. Elec. Assn. Describes this type, claiming advantages over other forms and giving results of tests made. 3500 w. Can Engr—July, 1904. No. 63854.

The Nozzles of the DeLaval Steam Turbine (Zur Frage der Lavalschen Turbinendüsen). Karl Büchner. An examination of the manner in which the form of the nozzle affects the expansion of the steam, discussing the experiments of Mollier, Fliegner, Rosenhain and the author. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—July 9, 1904. No. 63910 D.

The Rateau Steam Turbine (La Turbine á Vapeur du Systeme Rateau). J. Rey. An exhaustive review of the design and applications of the Rateau turbine, with data and results of tests. 20000 w. 1 plate. Mem Soc Ing Civ de France—April, 1904. No. 63941 G.

The Steam Turbine and Its Applications (Die Dampfturbinen und ihre Anwendungen). W. Boveri. Discussing especially the Parsons turbine as made by Brown, Boveri & Co., of Baden, Switzerland. 8000 w. Stahl u Eisen—July 1, 1904. No. 63951 D.

The Steam Turbine—the General Theory, and That of Its Special Types. M. Blieden. Extract from a paper on the methods of compounding, types, governing, efficiencies, &c. 9000 w. Jour of So. African Assn of Engrs—April, 1904. No. 64143 E.

The Zoelly Steam Turbine (Die Dampfturbine System Zoelly). J. Weishaüpl. A detailed description of the improved steam turbine built by Escher, Wyss & Co., of Zürich, Switzerland. Two articles, 3500 w. Schweiz Bauzeitung—June 18, 25, 1904. No. 63966 each B.

Stokers.

Mechanical Stokers. W. Rogers. Briefly describes the principles of the different forms of mechanical stokers, giving illustrations and discussing details. 3200 w. Elec Engr, Lond—June 24, 1904. No. 63642 A.

The Mechanical and the Human Operator. Edwin Yawger. Abstract of a paper before the Boston Convention of the Nat. Elec. Lgt. Assn. Presents some of the general considerations that bear on the art of combustion of fuel in boiler furnaces. Discusses the points needed by stokers to insure economy and the shortcomings of the human element on both kinds of firing. 3000 w. Am Electn—July, 1904. No. 63677.

Superheating.

The Specific Heat of Superheated Steam. Robert H. Smith. A discussion of the investigations made by Prof. H. Lorenz for making exact measurement of the specific heat, and of his results. A graphic interpretation of the results is given and explained. 2500 w. Engr, Lond—July 8, 1904. No. 63895 A.

Water-Hammer.

Water-Hammer in Steam Pipes. Gives cases of entrapped water in piping which have caused accidents. Ills. 1500 w. Locomotive—July, 1904. No. 63721.

MISCELLANY.

Aeronautics.

A New Aerial Screw Propeller (Sur une Nouvelle Hélice Aérienne). H. Hervé and H. La Vaulx. Data and results of experiments with propellers, giving the elements of the type which showed the best results. 1200 w. Comptes Rendus—June 27, 1904. No. 63922 D.

The Barton Airships. Four views of this large airship, with information con-

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cerning its equipment. 500 w. Auto Jour—July 9, 1904. No. 63879 A.

The Equilibrating of Dirigeable Balloons (Sur l'Empennage des Carènes des Ballons Dirigeables). Ch. Renard. A discussion of the proper form of gas bag to insure the maximum degree of stability in a balloon. 1200 w. Comptes Rendus—June 20, 1904. No. 63919 D.

The New Nemethy Flying Machine and the Principle of Its Construction. Dr. Alfred Gradenwitz. States the rules followed, and gives an illustrated description. 1500 w. Sci Am—July 9, 1904. No. 63729.

The Stability of Dirigeable Balloons (Sur la Stabilisation de Route des Ballons Dirigeables). Henri Hervé. A discussion of the form of balloon and arrangement of propeller and guide vanes to secure maximum stability. 1000 w. Comptes Rendus—July 4, 1904. No. 63923 D.

Exhibition.

The Bradford Exhibition. Begins an account of this exhibition in England, being held to celebrate the opening of a fine building given as a memorial to Cartwright, the inventor of the power loom, and the originator of the wool-combing machine. Ills. 1800 w. Engr, Lond—June 24, 1904. Serial. 1st part. No. 63652 A.

Ferris Wheel.

Taking Down and Re-erecting the Ferris Wheel. Describes the interesting engineering work in handling a structure of great dimensions and weight, at a great height. Ills. 2300 w. Eng Rec—July 9, 1904. No. 63781.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

The Influence of the Strength of Coal Briquettes upon Their Steaming Value (Der Einfluss der Festigkeit von Steinkohlen briketts auf ihre Verdampungsfähigkeit). E. J. Constam. Data and results of tests, showing the steaming value of briquettes to be unaffected by their broken condition. 2000 w. Zeitschr d Ver Deutscher Ing—June 25, 1904. No. 63903 D.

China.

Notes on the Coal- and Iron-Fields of Southeastern Shansi, China. William H. Shockley. A record of observations made in the service of the Pekin Syndicate during the first months of 1898, among the coal- and iron-fields of Southeastern Shansi, one of the largest anthracite regions known. Ills. 10800 w. Trans. Am. Inst of Min Engrs—Oct., 1903. No. 64121 C.

Coal-Cutting.

Coal-Cutting by Machinery. G. L. Kerr. Illustrates and describes types of machines used in the mines of the United Kingdom, their working, &c. Also discusses the conditions suitable for coal-cutting machines, timbering, motive power, cost, advantages and disadvantages. 18000 w. Ir & Coal Trds Revs—June 24, 1904. No. 63656 A.

Coal Handling.

Modern Coal-Hoisting Apparatus. Frank C. Perkins. Illustrations with notes on examples of cranes, hoisting towers, engines and buckets. 1100 w. Sci Am Sup—July 30, 1904. No. 64156.

Colliery.

The Vesta No. 4 Colliery. Illustrated description of a mine in Western Pennsylvania, of interest because of its costly equipment. 2800 w. Eng & Min Jour—June 30, 1904. No. 63623.

Coal Storage.

See Marine and Naval Engineering.

Exhibiton.

The Colliery Exhibition. An account of the opening at Islington, with brief illustrated descriptions of the exhibits. 31500 w. Col Guard—July 1, 1904. No. 63751 A.

The Colliery Exhibition. An illustrated general survey of the exhibits at the Royal Agricultural Hall, London, N. 19000 w. Ir & Coal Trds Rev—June 24, 1904. No. 63655 A.

Queensland.

Queensland Coal Mining Industry. Extracts from the report of the Inspector of Mines for the year 1903. Information concerning output, quality, mines, &c. Ills. 5500 w. Queens Gov Min Jour—May 14, 1904. No. 63601 B.

COPPER.

Arizona.

The Ore Deposits of Bisbee, Arizona. F. L. Ransome. Information in regard to these mines, which produce principally copper. 2200 w. Min & Sci Pr—July 16, 1904. Serial. 1st part. No. 64062.

Concentration.

Ore Dressing at Cananea. Dwight E. Woodbridge. Describes the new concentration mill of the Green Consolidated

Copper Company, the ores, and the methods used. Ills. 1200 w. Eng & Min Jour—June 30, 1904. No. 63624.

Extraction.

Wet Processes of Copper Extraction. Lionel C. Ball. Brief descriptions of the different wet processes likely to be suitable for Queensland ores. 8000 w. Queens Gov Min Jour—May 14, 1904. Serial. 1st part. No. 63602 B.

Mexico.

Copper Deposits in Sinaloa and Southern Sonora. Forbes Rickard. Notes and impressions during a recent visit to this mining region. 2500 w. Eng & Min Jour—July 21, 1904. No. 64029.

Mines.

The Planet Copper Mines. H. L. McCarn. A section of the Planet gulch and hill in Arizona, with description of the iron and copper deposits. 1500 w. Eng & Min Jour—July 7, 1904. No. 63700.

Ores.

Copper-Ore and Garnet in Association. William P. Blake. Shows the wide distribution of garnet as an associate of copper ore, discussing briefly the origin of these formations. 1500 w. Trans Am Inst of Min Engrs—Oct, 1903. No. 64119.

Veins.

Butte Copper Veins. Horace V. Winchell. Illustrates graphically the main points of structure, mineralization and associated rocks, stating the facts shown. 1000 w. Eng & Min Jour—July 7, 1904. No. 63697.

GOLD AND SILVER.

Assay Furnace.

A Portable Assay Furnace. J. J. Gillis. Gives results of a trial extending over several months of fairly frequent work, and under all sorts of conditions, in which kerosene was used in a modified gasoline furnace. 1800 w. Aust Min Stand—May 19, 1904. No. 63636 B.

Australia.

Black Range Goldfield (W. A.) A report of this field, which promises to become a large producer in the near future. 2500 w. Aust Min Stand—June 2, 1904. No. 64069 B.

Broken Hill. Donald Clark. An illustrated review of this noted mining region, yielding gold, silver and lead. 1700 w. Aust Min Stand—June 9, 1904. Serial. 1st part. No. 64074 B.

The Indicators of Daylesford. Describes this goldfield, reviewing briefly the history of its workings. Ills. 1600 w. Aust Min Stand—June 2, 1904. No. 64072 B.

Bendigo.

The Future of Bendigo (V.). W. H. Cundy. Begins an account of this important gold-producing center in Victoria. 1400 w. Aust Min Stand—May 26, 1904. Serial. 1st part. No. 63638 B.

Cyanide.

The Care of Cyanide Solutions. W. H. Davis. Discusses the application of solution schedules and the precautions to be exercised in their handling. 2000 w. Eng & Min Jour—July 21, 1904. No. 64030.

The Refining of the Precipitates Obtained by Means of Zinc in the Cyanide Process of Gold and Silver Extraction. G. Howell Clevenger. Explains the nature of precipitates, giving a report of experimental work upon alloys; reviews the present methods of refining, concluding that smelting with lead, after the removal of the zinc, is best. 8500 w. Trans Am Inst of Min Engrs—Oct, 1903. No. 64112 C.

Egypt.

Gold Mining in Egypt. Charles F. Alford. Abstract from Trans. of the Inst. of Min. & Met. Gives some facts in regard to ancient mines which have been rediscovered and are again being worked. 1200 w. Ills. Mines & Min—July, 1904. No. 63827 C.

Free Gold.

Free Gold Below the Zone of Surface Oxidation. Arthur Lakes. Cites instances where free gold is found, and inferences drawn from the facts. 600 w. Min Rept—July 14, 1904. No. 63861.

Milling.

Gold Milling. Algernon Del Mar. Notes giving information in regard to mill work. 2800 w. Min & Sci Pr—July 16, 1904. Serial. 1st part. No. 64061.

Notes on Mill Construction, Milling and Amalgamation. Discussion of I. Roskelley's paper on this subject. 16500 w. Jour of Chem, Met & Min Soc of S. Africa—May, 1904. No. 63883 E.

Nome.

Possibilities of Quartz Mining in Nome District, Alaska. F. Lundstrom. Describes the characteristics of the district, and considers that quartz mining ought to be successful. 900 w. Min & Sci Pr—July 9, 1904. No. 63862.

Placers.

Blasting Tight Placers Before Dredging. Oliver B. Finn. An illustrated detailed account of the way a Keystone driller was used in California to loosen, by blasting, a very tight gravel deposit, preparatory to dredging. 900 w. Eng & Min Jour—July 7, 1904. No. 63698.

Sampling.

The Sampling of Mill Dumps or Tailing Ponds. A. W. Warwick. Gives the meth-

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od adopted by the writer, illustrating by example. 1500 w. Min Rept—July 21, 1904. No. 64058.

Separation.

Separation of Gold from Copper. F. R. Carpenter. An account of investigations made to devise some dry method whereby the matte might be refined at the plant where it is made. 1800 w. Aust Min Stand—May 12, 1904. No. 63635 B.

Siberia.

The Gold Mining Districts of Central Siberia. Lewis Blanchard Brown. Describes the South-central part of Siberia, with special reference to its geology and mineral deposits. Map. 10300 w. Trans Am Inst of Min Engrs—Oct, 1903. No. 64113 C.

Smelting.

The Custom Smelting Industry in Mexico. Jas. W. Malcolmson. A statement of the present situation and of the changes being made to relieve it. Treatment rates are discussed and the advantages which copper matte has over lead as a vehicle for the concentration of gold and silver contained in silicious ores. 1800 w. Eng & Min Jour—July 7, 1904. No. 63699.

Water.

The Modern Theories of the Flow of Water and Their Application in Gold Mining. Prof. H. S. Hele-Shaw. A study of the ways in which water moves. Ills. 5500 w. Jour of Chem, Met, & Min Soc of S. Africa—May, 1904. No. 63884 E.

IRON AND STEEL.

Cast Iron.

See Mechanical Engineering, Materials.

Cementation.

Recent Experiments upon the Cementation of Carbon and Special Steels (Nouvelles Recherches sur la Cementation des Aciers au Carbone et des Aciers Speciaux). Léon Guillet. Determinations of the rapidity of penetration of the carbon for different materials of cementation. 1000 w. Comptes Rendus—June 20, 1904. No. 63920 D.

The Cementation of Special and Carbon Steels (La Cémentation des Aciers au Carbone et des Aciers Speciaux). Léon Guillet. Applying the methods of metallography to the study of cementation of steel showing the action of different materials. 8000 w. 1 plate. Mem Soc Ing Civ de France—Feb., 1904. No. 63934 G.

Electric Smelting.

The Electro Metallurgy of Iron and Steel. Emile Guarini. Reviews the progress made thus far in melting metals by electricity, 1200 w. Sci Am Sup—July 30, 1904. Serial. 1st part. No. 64158.

The Electric Smelting of Iron and Iron Alloys (Die Elektrothermische Erzengung von Eisen und Eisenlegierungen). B. Neumann. Illustrating and describing various forms of electric furnaces for smelting iron and refining steel. Serial. Part I. 3500 w. Stahl u Eisen—June 15, 1904. No. 63946 D.

The Manufacture of Iron by Electrochemical Processes. Adolphe Minet. A complete and fully illustrated review of the new methods of electric smelting, and their results. 5000 w. Engineering Magazine—August 6, 1904. No. 63977 B.

Magnetic Ores.

Origin of the Magnetic Iron-Ores of Iron County, Utah. E. P. Jennings. Describes these deposits, and gives the writer's conception of their origin. Ills. 1200 w. Trans Am Inst of Min Engrs—Feb, 1904. No. 64126.

Mexico.

A Rolling Mill at Monterey, Mexico (Walzwerksanlage in Monterey, Mexiko). Oskar Goldstein. With plan of the works and views of the various departments. Rails and structural shapes are rolled. 2000 w. 1 plate. Stahl u Eisen—June 15, 1904. No. 63947 D.

Open-Hearth.

Notes on Processes for Producing Open-Hearth Steel. R. M. Dallen. An illustrated article written chiefly for the purpose of making a comparison between the basic-Bessemer and the open-hearth processes. 3600 w. Ir & Coal Trds Rev—June 24, 1904. No. 63657 A.

Pig Iron.

See Mechanical Engineering, Material.

Scandinavia.

Iron Ore Mining in Scandinavia. W. Fischer Wilkinson. Read before the Inst. of Min. & Met. Information concerning the deposits, and the importance to this industry of the recently constructed railroad which gives access to the Atlantic port of Narvik. Ills. 4300 w. Ir & Coal Trds Rev—July 1, 1904. No. 63771 A.

Steel.

The Synthesis of Bessemer Steel. F. J. R. Carulla. A discussion of the value of the Bessemer process, urging its restoration to the confidence it deserves. 4400 w. Eng News—July 7, 1904. No. 63704.

MINING.

Alaska.

The Investigation of Alaska's Mineral Wealth. Alfred H. Brooks. An outline of what has been and is being accomplished toward furthering the knowledge of Alaska's mineral wealth, giving the operations of the U. S. Geol. Survey in the Territory. Map. 6000 w. Trans Am Inst of Min Engrs—Sept, 1904. No. 64115.

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Brakes.

Hoisting-Engine Brakes. J. S. Lane. Illustrates and describes the different kinds, the methods of operating them and the principles governing their construction and action. 2700 w. Mines & Min—July, 1904. No. 63812 C.

Concentration.

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Tank Locomotive with Seven Axles for Mountain Railways (Locomotive Tender à Sept Essieux pour Chemins de Fer de Montagne). Description of powerful mountain locomotive by Henschel, of Cassel. 1500 w. 1 plate. Génie Civil—July 2, 1904. No. 63916 D.

The Mallet Duplex Compound Locomotive; Baltimore & Ohio Ry. Illustrated detailed description of this remarkable locomotive of 334,500 lbs. weight, carried on 12 wheels. 1700 w. Eng News—June 30, 1904. No. 63586.

The New Four-Cylinder Compound Locomotives of the Orleans Railway (Les Nouvelles Locomotives Compound de la Compagnie Orleans). P. Conte. Illustrated description of heavy express and freight engines of the de Glehn type. 6000 w. 5 plates. Rev Gen des Chem de Fer—July, 1904. No. 63932 G.

Oil Burners.

A New Arrangement of Fuel Oil Burners for Locomotives. Brief illustrated description of a new method brought out by the Southern Pacific Ry. 500 w. Am Engr & R R Jour—July, 1904. No. 63726 C.

Oil Cup.

Automatic Air-Cylinder Oil Cup. Illustrated description of a device recently perfected by the Westinghouse Air Brake Co. 700 w. Loc Engng—July, 1904. No. 63724 C.

Resistances.

Resistance to Locomotive Traction at High Speeds. Discusses the methods of finding the resistance to the motion of a train in the experimental investigations made. 2000 w. Engng—July 8, 1904. No. 63894 A.

Safety Appliances.

Safety Appliances and Their Mainte-

We supply copies of these articles. See page 1037.

nance. George Hannauer. Read before the meeting of Cent. Assn. of R. R. Officers. Suggestions for the economical maintenance of power brakes, automatic couplers, &c. 3000 w. Pro St Louis Ry Club—June 10, 1904. No. 63628.

Steaming.

Locomotive Steaming Capacity. L. L. Bentley. Describes method of finding the steaming capacity, giving the results of a study of compound engines. 1200 w. Am Engr & R R Jour—July, 1904. No. 63-725 C.

Vibration.

The Vibration of Railway Vehicles. Gives an account of a new method, invented by M. Sabouret, by which a full report can be drawn of the state of the line and of the technical conditions observed when it was laid down. Ills. 3300 w. Engr, Lond—July 15, 1904. No. 64101 A.

NEW PROJECTS.

China.

The Construction of the Lu Pao Section of the Lu-Han Railway. From a paper by T. J. Bourne presented to the Inst. of Civ. Engrs. Describes the construction of about 90 miles of this line. 2200 w. Eng Rec—July 23, 1904. No. 64049.

Isthmus Route.

The Tehuantepec Route. E. L. Corthell. An account of the fulfillment of the project for a traffic route across this isthmus, the difficulties overcome, the advantages and value of this route. Ills. 5000 w. R R Gaz—July 15, 1904. No. 63798.

Light Railway.

The Leek and Manifold Valley Lignt Railway. Illustrated detailed description of this recently opened road which has novel features of interest. 3000 w. Tram & Ry Wld—July 14, 1904. No. 64137 B.

Tunnels.

A Channel Railway. Henry Haguet. Discusses the prospect of a tunnel railway connecting France and England. 2300 w. Transport—July 8, 1904. No. 64-024 B.

PERMANENT WAY AND BUILDINGS

Air Line.

The Atlanta & Birmingham Air Line. Illustrations, line drawings, and interesting data in regard to this road. 1500 w. R R Gaz—July 1, 1904. No. 63627.

Construction.

Impressions of a Resident Engineer on Railroad Construction. Friend P. Williams. Describes the location and construction of eight miles of modern railroad, reviewing the engineering side of the work and discussing points of special interest. 3000 w. Ills. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63606 F.

Culvert.

An Eighteen-foot Culvert, Bangor & Aroostook Railroad. Moses Burpee. An illustrated description, explaining the reason for making the span large, and also describing the construction. 800 w. Eng Rec—July 23, 1904. No. 64051.

Improvements.

The Atlantic Avenue Improvement of the Long Island Railroad in Brooklyn, N. Y. James B. French. An illustrated detailed description of the character and details of this work; it includes subway construction, steel viaducts, open cut, &c. 4500 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63604 F.

The Bridgeport Improvements of the New York, New Haven & Hartford Railroad. A statement of the conditions at this point, and an illustrated detailed description of difficult work in eliminating grade crossings and four-tracking this road without interfering with traffic. 2200 w. Eng Rec—July 23, 1904. Serial. 1st part. No. 64050.

Rails.

Bending Moments in Rails. Dr. P. H. Dudley. Read before the Am. Soc. of Test. Materials. Considers some of the relations of the problems of the rail section as a girder in carrying and distributing the load of passing locomotives to the foundation or sub-grade, as indicated by the bending moments. 2300 w. Ry & Engng Rev—July 2, 1904. No. 63719.

Stremmatograph Tests of Unit Fiber Strains and Their Distribution in the Base of Rails under Moving Locomotives, Cars and Trains. P. H. Dudley. Read before the Am. Sec. of the Internat. Soc. for Test. Materials, with revision and additions. Explains the functions of the stremmatograph and gives a record of the tests. 6800 w. Ills. Bul Int Ry Cong—June, 1904. No. 63767 E.

The Rail Section on Flexible Supports Under Rolling Loads a "Constrained Beam." P. H. Dudley. Reviews the researches of Mr. A. Flamache on the bending of rails, and gives other important data obtained by instrumental observations of precision of a different character, for the purpose of acquiring information of the strains in rails under moving loads. 4600 w. Bul Int Ry Cong—June, 1904. No. 63766 E.

Signalling.

Electric Signalling on Railways. Illustrates and describes the apparatus devised by Mr. Jan Voet, for repeating all signals on the engine. 1800 w. Elec Rev, Lond—July 1, 1904. No. 63747 A.

We supply copies of these articles. See page 1037.

The Electric Signal System of the Central Railway Station at Antwerp (Appareils pour la Manœuvre Electrique des Aiguillages et des Signaux de la Gare Centrale d'Anvers). L. Weissenbruch. A general description of the Siemens electric switch and signal system at Antwerp. 7500 w. Rev Gen des Chem de Fer—July, 1904. No. 63933 G.

The Electro-Pneumatic Signal System of the Est Station in Paris (Manœuvre Electropneumatique des Signaux à la Gare de Paris-Est). E. Wagner. An account of the installation of the Westinghouse signal system in the terminal of the Eastern Railway of France at Paris. 1800 w. Génie Civil—July 9, 1904. No. 63917 D.

What Are the Merits of the Block System on Railroads Operating in Iowa. P. G. Campbell. Considers the details of manual blocking and the benefits. General discussion. 3500 w. Pro Iowa Ry Club—June 13, 1904. No. 63616.

Stock Yards.

Railway Stock Yards and Their Relation to the Train Department, Freight Department and Maintenance of Way Department. Also general discussion. 3000 w. Pro Iowa Ry Club—June 13, 1904. No. 63615.

Superstructure.

Recent Studies in the Superstructure of Railways (Neue Beobachtungen, Messungen, und Versuche am Eisenbahn-Oberbau). Dr. Haarmann. An address before the Berlin Railway Societv discussing the changes necessary in permanent way to meet the modern demands. 7000 w. Glasers Annalen—June 15, 1904. No. 63952 D.

Tracks.

German Track and Signal Exhibit at the World's Fair. An illustrated description of the exhibit, explaining its working. 1800 w. Ry & Engng Rev—July 23, 1904. No. 64060.

Premium Track Inspection. Gives results of the annual inspection of track on one English and two American railroads, all of which have adopted the premium system of rewarding good work in that department. 1800 w. R R Gaz—July 22, 1904. No. 64033.

Trestles.

High Timber Trestles on the North Alabama Railroad. Illustrates and describes important trestle work from 60 to 80 feet high from foundation to rail. One is 116 feet in maximum height and is 684 feet long. 500 w. Eng Rec—July 23, 1904. No. 64053.

The Paoli Trestle on the Monon. A. E. Kemmer. Illustrates and describes a new steel trestle on the C. I. & L. Railroad, 870 ft. long and 87 ft. high. Includes about 4,300 cu. yds. of masonry. 500 w. R R Gaz—July 15, 1904. No. 63796.

Tunnels.

See Civil Engineering, Construction.

TRAFFIC.

Tonnage.

The Most Economic Tonnage Rating for a Locomotive in Freight Service. Papers by V. F. Finch, and by Harry Bentley, discussed together. 3000 w. Pro Iowa Ry Club—June 13, 1904. No. 63617.

STREET AND ELECTRIC RAILWAYS

Alternating Currents.

Adaptation of Alternating Currents to Railways. P. M. Lincoln. A statement and discussion of the transportation problem, reviewing the development of electric railroading, the use of direct-current motors, the rotary converter, &c., and discussing the single-phase alternating current motor and its advantages. General discussion. 9000 w. Pro Engrs' Soc of W Penn—April, 1904. No. 64129 D.

Australia.

Sydney's Tramway System. An illustrated article giving an historical review of its growth and progress, fully describing the present electric system, the power, rolling stock, traffic, financial condition, &c. 15800 w. Aust Min Stand—May 19, 1904. No. 63637 B.

Berlin.

The Electric Elevated and Underground Railway of Berlin. Paul Möller. A fully illustrated description of the features of construction, equipment, and operation. 3000 w. Engineering Magazine—August, 1904. No. 63972 B.

The Electric Elevated and Underground Railway at Berlin. An illustrated detailed description of the line, with an account of the project. 5700 w. Trac & Trans—July, 1904. Serial. 1st part. No. 64000 E.

Cars.

New Cars for the Schenectady Railway Company. Illustrated description of fine interurban cars. 2000 w. St Ry Jour—July 16, 1904. No. 63858 C.

Electrification.

Electric Traction on the Metropolitan

We supply copies of these articles. See page 1037.

Railway. Illustrated detailed description of the work of equipping their lines for electric traction. 12000 w. Tram & Ry Wld—July 14, 1904. No. 64136 B.

Extension.

A New Route from London to Uxbridge. An illustrated account of the latest extension of the Metropolitan Railway, opened July 4. 1400 w. Transport—July 8, 1904. No. 64021 B.

Heavy Traction.

Heavy Electric Traction by Alternating Currents. P. M. Lincoln. Discusses the advantages and the reason of the slow adoption of electricity for heavy traffic in the United States. 2400 w. Can Engr—July, 1904. No. 63853.

High Speed.

The Marienfelde-Zossen High-Speed Trials. Dr. Alfred Gradenwitz. Illustrates and describes the line, and gives an account of the trials of 1901-3. 3800 w. St Ry Rev—July 20, 1904. No. 64103 C.

Interurban.

The Cleveland, Painesville & Ashtabula Electric Railway. Illustrates and describes a line built entirely on private right of way. 4500 w. St Ry Jour—July 16, 1904. No. 63856 C.

The Springfield, Troy and Piqua Electric Railway. An illustrated detailed description of a fine interurban line in Ohio, and its equipment. 5500 w. St Ry Jour—July 23, 1904. No. 64068 C.

The Why and How of Interurban Railways. Guy Morrison Walker. Discusses the advantages of these railways, giving much information of the increase in wealth due to improved transportation, and giving suggestions for developing these roads. 6000 w. St Ry Rev—June 20, 1904. No. 63674 C.

Jungfrau.

The Jungfrau Railway (Le Chemin de Fer de la Jungfrau). L. J. Sidler. An account of the portion of the line already completed and in operation with especial reference to the design of the polyphase electric locomotives. Two articles, two plates. 5000 w. Génie Civil—June 18, 25, 1904. No. 63913 each D.

Narrow Gauge.

St. Georges de Commiers-la Mure Electric Railway. Describes this narrow gauge railway in the French Alps and its rolling stock. It is used mainly for goods traffic. 2300 w. Trac & Trans—July, 1904. No. 64003 E.

Power Station.

Kingsbridge Power Station of the New York City Railway Company. Illustrated detailed description. 4500 w. Eng Rec—July 2, 1904. No. 63660.

New Power Installation of the Twin City Rapid Transit Company. Illustrates and describes the addition to the power equipment recently found necessary for the line connecting Minneapolis and St. Paul, Minn. 4800 w. St Ry Rev—July 20, 1904. No. 64102 C.

The Kingsbridge Power Station of the New York City Railway Company. Illustrated detailed description of this large power plant and its equipment. 6500 w. St Ry Jour—July 2, 1904. No. 63668 C.

The Missouri River Power Station of the Metropolitan Street Railway Company of Kansas City, Mo. Howard Prescott Quick. Explains the situation in Kansas City, giving an illustrated detailed description of the design, and arrangement of the plant, its equipment, &c. Ills. 8000 w. St Ry Rev—June 20, 1904. No. 63675 C.

The North-Eastern Railway and Carville Power House. Illustrated detailed description of this station. The arrangement of the switch gear is of special interest. 3500 w. Elect'n, Lond—July 1, 1904. Serial. 1st part. No. 63750 A.

Repair Shop.

An Important New Street Railway Repair Shop at Portland, Me. Illustrated description of a new shop installation under construction. 1700 w. St Ry Jour—July 2, 1904. No. 63669 C.

Repair Shop Practice in Columbus, Ohio. Brief illustrated description of these shops and their work. 2000 w. St Ry Jour—July 9, 1904. No. 63778 C.

Rules.

Rules Governing Car Wiring and Equipment of Cars. Gives rules recently adopted by the Underwriters' Nat. Elec. Assn. as embodying the principal precautions necessary in safeguarding cars from fire hazard of their own electrical appliances. 3500 w. St Ry Jour—July 16, 1904. No. 63857 C.

Surface Contact.

Commercial Practicability of Electric Traction by Surface Contacts. C. E. C. Shawfield. A comparison between the overhead system and the surface-contact system. Ills. 5000 w. Elec Engr, Lond—July 1, 1904. Serial. 1st part. No. 63746 A.

Wheels.

Inspection and Care of Car Wheels. R. B. Stearns. An explanation of the inspection system on the Northwestern Elevated R. R. of Chicago. Ills. 2000 w. St Ry Rev—June 20, 1904. No. 63673 C.

We supply copies of these articles. See page 1037.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.

Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Alternating Currents.

Alternating Currents: Their Generation, Distribution and Utilization. By George T. Hanchett, M. E. Size, 7½ by 5 in.; pp. iii, 175. Many illustrations. Price, $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

A happy medium between the severely mathematical treatises on alternating currents and the popular expositions, is struck by this book, which is written especially for engineers who have a good knowledge of direct-current work, but who have not had an opportunity to familiarize themselves with alternating-current phenomena. The first chapter gives some very ingenious hydraulic and mechanical analogies which are a decided help to a clear conception of the influence of inductance and capacity in alternating-current circuits, and prepare the reader for the chapters which follow. After the general principles of alternating currents are laid down, the single-phase transformer is described; then come chapters on phase difference and vector summation, polyphase circuits and alternating-current measurements. The induction motor, the rotary converter. alternating-current generators and synchronous motors are next described, and the concluding chapters discuss the management of alternating-current machinery. Many diagrams and illustrations of apparatus help to make a clear and successful treatment of a subject which is by no means easy.

Copper.

The Copper Handbook. A Manual of the Copper Industry of the World. Vol. IV. By Horace J. Stevens. Size, 9 by 5 in.; pp. 778. Price, $5. Houghton, Mich.: Horace J. Stevens.

The Copper Handbook is out again, bigger and better than ever. This manual of the world's copper industry has made a place for itself as the authority in its chosen field, and each year it enlarges the sphere of its activity, gathering more facts and giving new information. As heretofore, the principal feature of the book is the chapter containing detailed descriptions, both financial and technical, of the copper mines of the world. This year there are 3,311 copper mines and copper mining companies on the list, the descriptions varying in length from a couple of lines to eleven pages, according to the importance of the property. This number shows an increase of just fifty per cent. over last year, while the chapter has been rewritten throughout and brought up to date. Other chapters are devoted to the history of copper, its geology, chemistry, mineralogy, metallurgy and uses, a very convenient glossary of mining terms, and descriptions of the copper deposits of all parts of the world. The last chapter contains the latest statistics of copper and the copper trade, and the entire work bears evidence of the painstaking care, personal attention and whole-hearted interest of the author.

Cross Ties.

Cross-Tie Forms and Rail Fastenings, with Special Reference to Treated Timbers. (Bureau of Forestry, Bulletin No. 50.) By Hermann von Schrenk. Size, 9 by 6 in.; pp. 70; plates, 5; figures, 71. Washington: U. S. Department of Agriculture.

With the diminishing supply of high-grade timber, owing to the rapid deforestation of some of the most important tree-producing areas in the United States, the railroads have increasing difficulty in obtaining wood for their various purposes and, particularly, for cross ties. Different substitutes for wooden ties, such as steel and concrete, have been suggested and in some cases tried with good results, but for the immediate future, as it has been in the past, wood will be by far the most largely used material for cross ties on American railroads. It becomes, then, of the highest importance to inquire into the methods of using this material to the greatest advantage, and such is the object of the present pamphlet, which discusses in a thoroughly practical, and, at the same time, truly scientific manner, the most economical forms of cross ties and the most efficient ways of fastening the rails to them. A new classification of ties, based upon their exact dimensions, is suggested, and a form, called the "half-round," is recommended for trial and adoption. Screw spikes, wooden screw dowels, wooden and iron tie plates, a convenient

machine for driving screw spikes rapidly, and other things connected with rail fastenings are illustrated and described, and accounts of recent European practice in this line are given. The author, Dr. von Schrenk, who is in charge of the division of Forest Products of the United States Bureau of Forestry, has had an extensive experience in the preservative treatment of timber and has done a great deal of good work in interesting the railway and telegraph and telephone companies in that subject, and this latest pamphlet of his should attract the close attention and serious consideration of maintenance-of-way departments in particular and of railroad men in general.

Reinforced Concrete.

Architects' and Engineers' Hand-Book of Reinforced Concrete Constructions. By L. J. Mensch. Size, 7½ by 5 in.; pp. 217; illustrations and figures, 172. Price (paper), $2. Chicago: Cement and Engineering News.

Structures of concrete reinforced by steel or iron are coming into such extensive use, that there is much room for a book giving a clear and simple account of the leading principles and chief applications of this form of construction. Such is the object of the present work, the subject matter of which is drawn largely from the writer's own experience as designer, consulting engineer and contractor for reinforced-concrete structures. After the introduction, there is a description of girders constructed on the Hennebique system and reports of successful tests of girders and floors. The use of reinforced concrete in various kinds of structures is then taken up, including floors; columns, reinforced both by longitudinal rods and by helically-wound wire, on the Considère system; footings for walls; piles and sheet piling; walls; stairs; skeleton buildings; retaining walls; dams; tanks, standpipes, cisterns and reservoirs; grain elevators, coal and ore bins; water pipes, sewers and culverts; chimneys; and bridges. Many illustrations of these applications are shown, and the book is concluded with general specifications for reinforced-concrete construction and the U. S. Engineer Corps specifications for Portland cement.

Tool Steel.

Points for Buyers and Users of Tool Steel. By Geo. W. Alling, M. E. Size, 8 by 5½ in.; pp. 224; illustrations, 65. Price, $2. New York: David Williams Company.

As indicated by its subtitle, this book is a review of the main sources of trouble met with by consumers of tool steel, and contains practical suggestions for avoiding them. The first part is directed especially to purchasing agents, with a view to assisting them in deciding what grade of steel is best suited to a particular use, and in discriminating among the great variety of steels offered to them. There are descriptions of how the different steels are made; it is shown why good steel is high priced, and why cheap steel is expensive to use in most cases, although under certain circumstances the cheaper grades may be employed to advantage. New methods and processes are criticized, and considerable attention is given to defects in steel, and the ways in which they are produced and detected. Part second is of special interest to the tool maker, the mechanic and other users of steel. It contains a great deal about annealing, hardening and other ways of working steel, methods of testing the quality and uniformity of steel, the grinding of cutting tools, and much other useful information. One chapter is devoted to the new high-speed steels, their use and treatment, another contains definitions of steel workers' terms, and there are useful tables and concise data. The illustrations are very instructive, and the whole work is an extremely practical one, being full of examples drawn from actual experience.

BOOKS RECEIVED.

The Theory of the Lead Accumulator. By Dr. Friedrich Dolezalek. Translated by Carl L. von Ende, Ph. D. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Floods of the Spring of 1903, in the Mississippi Watershed. Bulletin M., U. S. Weather Bureau. By H. C. Frankenfield. Washington: Weather Bureau.

Memoria de Obras Públicas (Report on Public Works in Cuba). by Manuel L. Diaz, Secretary of Public Works of the Republic of Cuba. Havana: Department of Public Works.

Technical Mechanics. By Edward R. Maurer. Price, $4. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Irrigation Engineering. By Herbert M. Wilson, C. E. $4. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

A Text-Book of Electrical Machinery. Volume I. Electric, Magnetic, and Electro-Static Circuits. By Harris J. Ryan, M. E. Henry H. Norris, M. E., and George L. Hoxie, M. M. E., Ph. D. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Industrial Uses of Water. By H. de la Coux. Translated from the French and revised by Arthur Morris. Price, 10s. 6d. ($4.50). London: Scott, Greenwood & Co. New York: D. Van Nostrand Co.

Graphic Statics, with Applications to Trusses, Beams and Arches. By Jerome Sondericker, B. S., C. E. Price, $2. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

NEWS SUPPLEMENT

The Engineering Magazine—April, 1904

Coming Society Meetings.

AIR-BRAKE ASSOCIATION. Sec.: F. M. Nellis, 174 Broadway, New York. Annual meeting May 10, at Buffalo.

AMERICAN ELECTROCHEMICAL SOCIETY. Sec.: C. J. Reed, 929 Chestnut St., Philadelphia. Next meeting April 7 to 9, at Washington, D. C.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, April 22, at Chemists' Club, 108 W. 55th St. Papers on Alternating-Current Generaors.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, April 27, at New York.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Joint meeting with the Institution of Mechanical Engineers of Great Britain, May 31 to June 3, at Chicago.

AMERICAN WATER-WORKS ASSOCIATION. Sec.: J. M. Diven, Elmira, N. Y. Annual convention, June 6 to 10, at St. Louis.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September, and November, Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

INTERNATIONAL ELECTRICAL CONGRESS. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12 to 17, at St. Louis.

INTERNATIONAL ENGINEERING CONGRESS. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting Oct. 3 to 8, at St. Louis.

IOWA ELECTRICAL ASSOCIATION. Sec.: W. S. Porter, Eldora. Convention, April 13 and 14, at Des Moines.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs, N. Y.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturdays.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention, May 24 to 27, at Boston.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meeetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Charles C. Brown, formerly assistant to Mr. O. H. Taylor, general passenger agent, N. Y., N. H. & H. R. R., Marine District, has been appointed general passenger and ticket agent of the Bangor & Aroostook Railroad Company, with office at Bangor, Maine.

—Mr. Konrad Meier, who was for ten years the chief assistant to Mr. A. R. Wolff, has opened an office at No. 27 East 22nd St., New York, as a consulting heating and ventilating engineer. He has lately published a pamphlet entitled, "Reflections on Heating and Ventilating Engineering."

—Mr. W. K. Palmer has removed his engineering offices to Suite 402, the Lyceum Building, Kansas City, Mo. In the new offices ample space and special facilities, together with the services of a corps of able

and experienced engineers, afford exceptional advantages for the prompt preparation of engineering plans, specifications, estimates and reports, and for the thorough supervision of engineering construction.

—Mr. Henry R. Dalton, Jr., has been elected president of the Baush Machine Tool Co., of Springfield, Mass., to take the place of Mr. W. H. Baush, resigned; and Mr. C. J. Wetsel has been elected treasurer, to fill the vacancy caused by the resignation of Mr. David Hunt, Jr.

—Mr. Philetus W. Gates and Mr. Henry W. Hoyt, respectively general superintendent and second vice-president of Allis-Chalmers Company, are about to retire from active participation in the management of that company. Mr. Gates was president and Mr. Hoyt secretary and general manager of Gates Iron Works for fifteen years prior to the incorporation of Allis-Chalmers Company in 1901. They have been prominently connected with the manufacturing interests of Chicago and have taken an active part in all of the manufacturers' associations. Messrs. Hoyt and Gates, after a well earned vacation spent in traveling, will re-engage in business in Chicago.

—Mr. George Frederick Gilbert died of typhoid fever at St. Mary's Hospital, Rochester, N. Y., on Jan. 12th, aged 42 years. In 1896, he became connected with the H. W. Johns-Manville Co., New York, and was their general sales agent for Northern and Western New York. He also represented the company in connection with work for the State Government.

Industrial Notes.

—An International Electrical Congress will be held at the St. Louis Exposition during the week beginning September 12th, to which official delegates will be sent by the governments of the principal countries of the world. Besides these delegates, there will be a large number of members of the Congress, made up of electrical engineers and others interested in electrical matters. Up to March 18, there were 1,128 acceptances of membership, and 136 papers had been promised. Each person joining the Congress and paying the fee of $5, will receive an engraved certificate of membership, and will be entitled to a copy of the proceedings, which will probably be issued in three volumes, of 800 pages each. The secretary of the Congress is Prof. A. E. Kennelly, Harvard University, Cambridge, Mass., and the treasurer is Mr. W. D. Weaver, 114 Liberty St., New York.

—The Chicago Meeting of the American Society of Mechanical Engineers is to be a joint session of that association and the Institution of Mechanical Engineers of Great Britain. Nearly two hundred members of the British Institution have expressed their intention of coming to America, and taking part in this joint meeting. It is the purpose of these visitors not only to attend an American Meeting, and thereafter visit the St. Louis Exposition, but to make the American visit the occasion of excursions to points of technical and manufacturing interest all through the United States.

—The Warren Brothers Company, of Boston and New York, have been awarded a contract in Cohoes, N. Y., for 22,000 square yards of their patented bitulithic pavement, at $2.48 per square yard, the pavement to be laid in Ontario, Vliet and Mangan streets. Their bid was within the engineer's estimate, and in preference to other paving materials, the bitulithic pavement was the practically unanimous choice of the taxpayers, after a thorough investigation of its merits.

—The Stirling Co., the water-tube boiler manufacturers, have removed their Cincinnati offices from the Neave building to the new concrete Ingalls building, Fourth and Vine Streets.

—The Carpenter Steel Co., in spite of their temporary embarrassment, are still actively engaged in the steel business. Their works are being run by Mr. Robert E. Jennings, as receiver, and their trade, considering the dullness of the times, was never better. They are constantly making and carrying in stock a full assortment of "Zenith," air-hardening and other special steels, out of which they can supply all orders promptly, and the quality of their material is making customers for them in every part of the country.

—The Cost-System and Auditing Company, of New York, have enlarged their business so much of late that they find it necessary to increase their facilities for

handling it, and will therefore remove their office to commodious quarters at 52 Broadway.

—The French Society of Civil Engineers are about to make a collection of plans and designs of engineering works, machines, etc., which will be properly classified and placed in their library. These plans willl be contributed by the members and others, and will be of great service to all the members and particularly to the younger associates.

—A. Wyckoff & Son Co., of Elmira, N. Y., manufacture a patent steam-pipe covering for preventing heat losses, which is especially suited for underground and exposed conditions and is permanently waterproof. They also make wood pipes for fresh water supply and for carrying acidulated liquors and mine waters.

—A very important installation of Pelton water wheels was recently completed near Placerville, Cal., for the American River Electric Company, consisting of two double Pelton units of a capacity of 2,500 horse power, operating under a head of 575 feet. This plant is situated on the American River, within a few miles of the State capital, Sacramento, and will generate electricity for near-by towns.

—The Nernst Lamp Company has recently closed contracts for the installation of 165 Nernst lamps in the Washington National Bank Building and 75 lamps for the Pittsburg Supply Company, at Pittsburg, Pa. They have also succeeded in securing the adoption of Nernst lamps by the Municipal Electric Light plant of Silverton, Col., in competition with enclosed arc lamps.

—One of the most interesting features of the new plant now being erected by the B. F. Sturtevant Co., at Hyde Park, Mass., is an elaborate testing plate for its engines. With an output of a thousand engines or more per year this is the essential climax of a careful system of manufacture and testing. The plate, or more properly the plates, will be supported upon a series of heavy parallel walls between which steam and exhaust pipes are carried so that at almost any point in the entire area of the floor, measuring about 30 feet by 60 feet, steam and exhaust connections may be made to any engine. Testing facilities will be provided, and a transfer crane overhead will make it very simple to locate or remove the engines. The same crane will transport them to the packing department, and thence load them directly upon cars which traverse the end of the building.

—The National Electric Company, successors to the Christensen Engineering Company, manufacturers of air-brake and electrical machinery, have just moved their executive offices and engineering department to their new building, located at their Milwaukee works. This building is constructed of cement blocks 2 feet long by 1 foot high and is 200 feet long by 66½ feet wide. Extensions and improvements are also being made in their shops, to supply the necessary facilities for handling the company's constantly increasing business.

—The Canada Corundum Company, Limited, of Toronto, have completed their new mill and are ready to make contracts to furnish customers with from one to three years' supply of pure Craig Mine corundum. Three years ago this product was first put upon the market. The demand for it has steadily increased, and last spring the erection of a new plant was begun, which is the largest abrasive mill ever erected in any country. Its capacity is from 5,000 to 8,000 tons per year of finished product. This product is absolutely uniform and orders can be duplicated indefinitely.

—The Underfeed Stoker Co. of America, of Chicago, issues *The Publicity Magazine*, devoted to the interests of the Jones Stoker. The February number contains illustrations and much information of interest to the managers of steam and power plants and to other users of coal under boilers.

—The Keasby & Mattison Co. have opened a department in their office, No. 84 John St., New York, for the direct sale of their technical products, which have been heretofore very generally handled by the trade of New York City and vicinity. These products comprise every style of their well-known magnesia sectional coverings, a most efficient heat insulator, containing 85 per cent. of pure carbonate of magnesia, this type of steam-pipe and boiler insulation having been originated by them. Their products also include standard asbestos moulded covering, absolutely free from harmful plaster of paris; asbestos inter-

lined felt coverings; asbestos air-cell coverings; corrugated wool felt coverings; asbestos building papers; asbestos fibre felts; asbestos packings, cloths and textiles of every possible description; theatre curtains of asbestos, gloves, mittens, stove mats, and many other asbestos articles.

—Among the most important orders for installations of Foster steam superheaters reported by the Power Specialty Company, of 126 Liberty St., New York, are those of the separately fired type in connection with the boilers of the Laclede Power Co., St. Louis, Mo., and the Williamsport Passenger Railway Co., Williamsport, Pa.; while of the combined type contracts have been awarded for Babcock & Wilcox boilers and Foster superheaters for the United States Naval Gun Factory, at Washington, and for the Columbia Improvement Co., Terre Haute, Ind., of which Messrs. Stone & Webster, Boston, are the engineers.

—The summer school of the University of Colorado, at Boulder, thirty miles north of Denver, will be open from June 20 to July 30.

—A convention of branch managers, department managers and salesmen of the H. W. Johns-Manville Co., was in session from Monday, February 15th to Saturday, February 20th. Representatives to the number of about thirty-five from all parts of the country, were present, the company having branches in New York, Milwaukee, Chicago, St. Louis, Boston, Philadelphia, Cleveland, Pittsburg, New Orleans, London. The delegates first met in Hartford, Conn., where they were the guests of the Johns-Pratt Co., manufacturer of the famous Sachs "Noark" enclosed fuses, line materials and other electrical goods for which the H. W. Johns-Manville Co., are sole agents. The object of the convention was to bring all branches into closer touch with each other and to give opportunity for a general discussion of all the enormously varied lined manufactured by this company.

—Plans for the Model Foundry, to be carried on in connection with the St. Louis Exposition, are now completed and it is expected that the construction of the building for that purpose will begin very soon. An unexpected delay occurred which has held back the promoters of the plan; but it is expected now that no further obstacles will be encountered to the carrying out of the design as originally formed. President Engler, of the Worcester Polytechnic Institute, has been asked to name a man to take charge of the erection of the building and of the foundry itself, after it is once in operation; and, as has been previously announced, the entire charge of the foundry throughout the summer will be in the hands of the Worcester Polytechnic Institute.

—Marine Iron Works (W. G. Nourse, Manager) of Chicago, recently wrote a letter to one of their New York customers, from which the following is an extract: "There is a feature in connection with this marine engine business in the small and medium size work (20 to 500 H. P.) that you will understand, viz.: If a concern which for a number of years had devoted their attention exclusively to their work, taking a real interest in it and keeping their more or less old patterns as nearly modern as circumstances would permit were to be totally wiped out by fire, and all of the patterns destroyed, you can realize that an ideal opportunity would be offered for either quitting entirely or starting fresh. If the latter plan is adopted, it presents the advantage of incorporating into new patterns all that was best in the old, together with many good features which the old designs would not permit. It was this latter plan that we selected and have been following for the past two years, and although it has been "hard sledding" at times, and at first a tremendous loss to us, it is proving, and we believe will continue to prove, a positive benefit. To-day our line of engine patterns, especially in compounds and triple expansions, is at least one hundred per cent. better and more complete than those that went up in smoke two years ago. If we could make these facts known to a larger proportion of the intelligent buyers of such machinery, it would be of value to all parties concerned, not excepting the users. You know, in fact everyone familiar with marine machinery within the range of work referred to knows, that no concern in the country could afford to deliberately destroy old patterns, neither is it possible to

make such changes as will always keep them up-to-date, and it requires some real calamity to compel builders to make an entire new and complete line. It might seem possible for a newly organized company to do this, but they could not have had that associated experience so necessary in discussing and deciding upon seemingly minor but really important details of construction."

—In a paper read by Mr. Perez M. Stewart before the International Association of Fire Engineers, it was stated that the best protection for wall openings in buildings "is to be found in the fireproof window glazed with wire glass, set in a sash and window frame of wood covered with metal, or of hollow metal entirely. Wire glass is made either with a translucent or polished surface, and the wire reinforcement, embedded in the glass itself, although keeping the window intact against the attack of a fire of almost any intensity, may be broken readily by the fireman when it becomes necessary to enter the building or introduce a fire stream. Among the recent important fires showing the efficiency of wire glass windows in reducing the exposure hazard, may be cited the Armour Lard Refinery, Union Stock Yards, Chicago; the Case Plow Works, in Racine, Wis., and the Mitchell Wool Warehouse, in Philadelphia. In each of these instances the spread of fire to very valuable properties standing but a few yards distant was prevented through the resistance offered by wire glass windows in the walls of the adjoining building."

—An International Engineering Congress, under the auspices of the American Society of Civil Engineers, will be held at the Universal Exposition, St. Louis, during the week of October 3d to 8th, 1904. The Congress will be one of a series of International Scientific Congresses to be held at the Exposition under the general authority and with the co-operation of the Director of Congresses. The development of engineering science during the past decade has been so rapid and has extended over so wide a field that the Universal Exposition at St. Louis seems to be a fitting time at which to review the work of the past and obtain an authoritative epitome of present practice. The object of the Congress is to secure a thorough international consideration of certain branches of engineering work which have been selected with special reference to their present interest and importance. In order to facilitate the work of the Congress and to insure the presentation of topics in a systematic manner, the Committee has prepared a list of the subjects which have been selected for review and discussion, it being understood that the list of subjects proposed is somewhat tentative, and may be slightly modified as the details of the programme are perfected. As a basis for discussion at the sessions of the Congress, the Committee has invited engineers specially qualified in each of the various branches to prepare a review of the development during the past ten years in that branch in the United States, together with a summary of present practice. Engineers in other countries, experienced in these various lines, will be specially invited to prepare similar papers presenting a review and summary of practice in their respective countries. It is proposed to print these papers in advance, in order that a full discussion at the various sessions may be elicited without giving up any time to the reading of papers at the Congress. All engineers in the United States and in all other countries are invited to become members of the Congress, to attend the sessions, and to take part in the discussions; or, if unable to attend, to forward written communications on any of the selected subjects. It is not expected that delegates will be formally appointed, it being intended that an opportunity to attend shall be afforded to any who may wish to become members of the Congress. The papers, together with the discussions upon them, will be collated and published in one or more volumes by the American Society of Civil Engineers. The membership fee in the Congress will be $5.00, which will entitle the member to participate in the Congress and to receive a copy of the published proceedings. Membership may be secured by forwarding this fee, with name and address, to the Secretary of the Committee, Charles Warren Hunt, 220 West 57th St., New York City, who will issue a receipt therefor. Each member will receive all notices, programmes, etc., issued in advance of the Congress.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Booklet containing valuable information regarding compressed air installations and descriptions and illustrations of air compressors, air valves, governors, intercoolers and other apparatus. 6 by 3½ in.; pp. 31. American Air Compressor Works, 26 Cortlandt St., New York.

Calculagraph.

Booklets describing the use of the calculagraph—which prints a record of the elapsed time in any operation, and, if desired, the time value, in dollars and cents—in telephone exchanges, factories and workshops, billiard rooms, and other places where it is desirable to measure time accurately and keep a permanent record of it. 6½ by 3½ in. Calculagraph Company, 9-13 Maiden Lane, New York.

Centrifugal Pumps.

Pamphlet, with well illustrated descriptions of the newest designs of turbine centrifugal pumps, for lifts up to 2,000 feet, and of conoidal and volute centrifugal pumps for more moderate heads. 9 by 6 in.; pp. 48. Henry R. Worthington, 114-118 Liberty St., New York.

Compressors.

Catalogue, with descriptions and half-tone illustrations of single, two, and three-stage air compressors, natural-gas compressors, blowing engines, intercoolers, and details of compressors for any service. 6½ by 10¾ in.; pp. 50. Nordberg Manufacturing Co., Milwaukee.

Concrete Mixer.

Booklet, with illustrated description of the Autometric concrete mixer, which automatically measures the ingredients, mixes them in any proportions desired, dry and wet, and discharges the concrete. 3½ by 6 in.; pp. 16. Campbell & Marsh, Milwaukee.

Conveying Machinery.

Booklet No. 6, containing illustrations and descriptions of conveying and elevating machinery for boxes, barrels, bales, packages and other kinds of freight, and coal handling and screening machinery. 8½ by 5¾ in.; pp. 45. Borden & Selleck Company, Chicago.

Countershaft.

Catalogue D, giving an illustrated description of the one-belt reversing counter-shaft, designed to operate screw machines, monitors, engine lathes and other machine tools requiring a forward and a reverse drive, without the use of two belts. 6 by 9 in.; pp. 16. The Smith Countershaft Co., Melrose, Mass.

Electric Instruments.

Bulletins Nos. 15 to 24, inclusive, containing illustrations, descriptions and prices of direct-current voltmeters and ammeters of various types, including illuminated-dial, portable, automobile and other patterns. 9 by 5¾ in.; pp. 4. Empire Electrical Instrument Co., 654 Hudson St., New York.

Electric Tools.

Booklet, containing illustrations and descriptions of the "Willey" electrically driven breast drills and portable grinders for center grinding and a wide range of other work. 6 by 3½ in.; pp. 16. Jas. Clark, Jr., & Co., Louisville, Ky.

Gas Engines.

P Catalogue, with descriptions and illustrations of "Charter" gas and gasoline engines and their applications to pumping, hoisting, sawing, propelling boats and other uses, and illustrated descriptions of "Sterling" portable gasoline engines. 6 by 9 in.; pp. 47. Also, sheets of testimonials from many users. Charter Gas Engine Co., Sterling, Ill.

Gears.

Catalogue No. 27, with flexible cloth binding, containing illustrated descriptions and price-lists of Walker machine-molded and pattern gears of every description, and illustrations of other power-transmitting, elevating and conveying machinery, together with useful information and tables. 9 by 6 in.; pp. 144. H. W. Caldwell & Son Company, Chicago.

Graphite.

Booklet devoted to Dixon's graphite pipe-joint compound, as put up in collapsible tubes, for screw joints of every sort, gaskets, bolts, nuts, and steam, water, gas, gasoline and oil piping. 6¼ by 3¼ in.; pp. 6. Joseph Dixon Crucible Co., Jersey City, N. J.

Graphite Paint.

Booklet describing the manufacture of graphite paint and its application to steel buildings, docks and piers, breweries, refrigerating machines, roofs, smokestacks, bridges and viaducts, power plants, ornamental iron work and other structures and machines; with many illustrations. 6 by 3 in.; pp. 16. Detroit Graphite Mfg. Co., Detroit.

Ice Machines.

Catalogue D, with illustrations and descriptions of many varieties of steel ammonia fittings for refrigerating machinery, and of other ice factory supplies. 9 by 6 in.; pp. 81. The Triumph Ice Machine Co., Cincinnati.

Indicator.

Circular, containing an illustrated description of the Star improved steam engine indicator, with an outside spring, which is elongated when in action. 9¼ by 6 in.; pp. 4. Star Brass Manufacturing Co., Boston.

Locomotives.

"Record of Recent Construction," No. 44, a pamphlet containing handsome illustrations and descriptions, in French and English, of Atlantic, consolidation, inspection and various other types of locomotives, built lately at the Baldwin Works. 6 by 9 in.; pp. 32. Baldwin Locomotive Works, Philadelphia.

Mining Machinery.

Large illustrated catalogue of hoisting engines and boilers, coal, coke and rock breakers and crushers, screens, coal tipples, mine cars, barrows, and a great many other kinds of mining machinery and apparatus. 12 by 9 in.; pp. 72. Kenney & Company, Scottdale, Pa.

Oil Burners.

Catalogue No. 4, containing illustrations and descriptions of Branch oil burners, for boiler furnaces and automobiles, for domestic use and other purposes, and of Branch steam traps. 6 by 9½ in.; pp. 24. Also, "Automobile Bulletin" No. 3 and circulars devoted to the Branch combined condenser and oil eliminator for steam vehicles and to various styles of oil burners. The National Oil Burner and Equipment Co., St. Louis.

Packings.

Catalogue, containing descriptions, illustrations and prices of ring, spiral, sheet and other forms of packing, made of rubber, cotton, flax, asbestos and other materials, and for use with steam, ammonia and water. 4½ by 6 in.; pp. 53. The Crandall Packing Co., Palmyra, N. Y.

Pumps.

General catalogue for 1904 of Knowles pumping machinery, including boiler feed pumps, mining pumps, air pumps, vacuum pumps, hydraulic-pressure pumps, wrecking and irrigating pumps, fire pumps and many other varieties, both steam and electric driven. Also, useful information and telegraph code. 7 by 5½ in.; pp. 137. Knowles Steam Pump Works, 114 Liberty St., New York.

"Pump Data" No. 4, a bulletin illustrating and describing the Aldrich vertical triplex pump operated by a high-speed electric motor through a silent chain drive. 9 by 6 in.; pp. 4. The Allentown Rolling Mills, Allentown, Pa.

Rail Joint.

Pamphlet, with illustrations and descriptions of the Heil improved cast-welded rail joint and the steel-jacket cast-weld rail joint, particularly adapted to electric railways, both city and interurban; of the Heil welding outfits, propelled by either electricity or steam; and of the sand-blast rail cleaner. 6¾ by 4¾ in.; pp. 18. The Heil Rail Joint Welding Co., Milwaukee, Wis.

Shaft Hangers.

Booklet, with illustrations and descriptions of the American Pioneer pressed steel shaft hangers, post hangers and floor stands, which have several valuable improvements, and combine maximum strength with minimum weight. 6 by 3½ in.; pp. 20. Standard Pressed Steel Co., Philadelphia.

Silicate Stone.

Illustrated pamphlet, reprinted from *The Magazine of Commerce*, describing the process of making a first-rate artificial building stone from sand and lime, and showing its many uses. 9½ by 7¼ in.; pp. 7. Also, an article reprinted from the *Brooklyn Eagle*, devoted to the same subject. Silicate Stone Company, 39 Wall St., New York.

Steam Engines.

Catalogue, containing well-illustrated and comprehensive descriptions of Nordberg Corliss steam engines and their details, jet and surface condensers, the Milwaukee feed-water heater and purifier, tables and useful information concerning steam engines and their installation. 6¾ by 10¼ in.; pp. 75. Nordberg Manufacturing Co., Milwaukee.

Steam Shovel.

Pamphlet, containing description, specifications and illustrations of a 30-ton traction steam shovel, with 1¼-cubic-yard dipper, suitable for a great variety of work, and constructed in a manner which combines great strength, capacity, propelling power and ease of handling. 10¾ by 6¾ in.; pp. 11. The Ohio Steam Shovel Co., Toledo, O.

Steam Traps.

Steam bulletin No. 10, containing illustrations and descriptions of the Branch steam trap, steam separators, the Klinger water glass, valves, couplings, and other steam supplies. 6 by 9½ in.; pp. 8. The National Oil Burner and Equipment Co., St. Louis.

Storage Batteries.

Bulletin No. 81, giving an illustrated description of the installation of Chloride accumulators in the power station of the San Francisco, Oakland & San Jose Railway Co., and the advantages resulting from their use. 10½ by 8 in.; pp. 4. The Electric Storage Battery Co., Philadelphia.

Tapes.

Catalogue, containing illustrations, descriptions and prices of all kinds of measuring tapes, made of steel, linen and other materials, in cases and on frames. 5½ by 3¼ in.; pp. 28. The Lufkin Rule Co., Saginaw, Mich.

Tools.

Catalogue for 1904, in cloth binding, containing illustrations and descriptions of milling machines, grinding machines, automatic gear-cutting machines, screw machines, cutters, accurate test tools and gauges, machinists' tools and many other machines and tools. 6 by 3½ in.; pp. xxii, 482. Brown & Sharpe Mfg. Co., Providence, R. I.

Well Machinery.

General catalogue, containing illustrations and descriptions of well-sinking outfits, prospecting, pumping and irrigating machinery, air compressors, Chapman's air water lift, gasoline and steam engines, boilers, and other kinds of well machinery, tools and fittings. 9 by 6 in.; pp. 160. The American Well Works, Aurora, Ill.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Ring, Disc and Collar Grinder.

THE grinder shown in the accompanying illustration was originally designed with special reference to grinding piston rings for automobiles, gasoline and steam engines and similar work, but its field is considerably more extensive than was at first thought, and it is found to be adapted also for a large amount of surface grinding on collars, discs, dies and cutters.

HEALD RING, DISC AND COLLAR GRINDER.

The machine consists of a magnetic chuck 8 inches in diameter, mounted on a vertical spindle with micrometer adjustment. The grinding wheel is mounted in a cross slide, which can be fed from the work by means of the hand wheel shown, or an automatic power cross feed will be added if desired. The chuck carrying the work is driven by a cone pulley with eight different speeds, so that the operator can obtain at all times the speed best adapted to the particular work in hand. An adjustment is provided with the

upper part of the column so that the machine can be made to grind hollow or crowning at the center of the chuck.

This latter feature is of value especially in grinding metal slitting saws, which need to be thinner at the center for clearance.

As above stated, the machine was particularly designed for fitting piston rings, experience having shown that the power of an engine can be increased 10 per cent. by having rings ground to fit the grooves more perfectly. In fitting up piston rings it is easy enough to make the grooves of a standard width and nicely finished, because the pistons are comparatively heavy and rigid and are large enough to be easily handled, but with rings it is different. These are usually cut off several at a time from a cylinder which has been turned to an approximate size. The edges of these rings as they come off are somewhat rough and, naturally, oversized. These can be held on the magnetic chuck in the most satisfactory manner, and, after being made perfectly true on one side, can be brought to an absolutely uniform thickness and made exactly right to fit into the grooves as perfectly as desired.

As piston rings are really double-seated check valves, it is important that they fit nicely to prevent the escape of the gases in the cylinder, which are under such high pressure.

COMMERCIAL ELECTRIC CO.'S INTERLOCKING CONTROLLER.

The design of this grinder has been most carefully studied out so that all bearings are protected from dust and are adjustable for wear.

The gearing is enclosed, and the distribution of metal is such that the machine is most rigid and will turn out splendid work. This grinder will handle a great variety of work usually done on more expensive machines, thus leaving the latter free for more complicated work.

Further information regarding this grinder will be gladly furnished by The Heald Machine Company, of Worcester, Mass.

Variable-Speed Motors for Single Voltage.

THE application of the electric motor to the propulsion of a great variety of machinery has developed the fact that special designs of machines are necessary in order to fulfill the requirements of the various classes of work which are to be accomplished, and the success of an installation depends upon the closeness with which its special requirements have been met.

COMMERCIAL VARIABLE-SPEED MOTOR.

The Commercial variable-speed motors herewith illustrated, are especially adapted to that class of machinery in which a great variation in speed is required, with the heaviest torque or pulling power at the slowest speed, and a less torque at a higher speed, the actual horse power or rate of doing work being the same at all speeds. Lathes, boring mills, milling machines, drills, with many others, belong to this class, and to secure the greatest output from them it is necessary to run the work at the greatest cutting speed and take the heaviest cuts the tool will stand, whatever may be the nature of the work, the power not being permitted to fall off when the motor is run at the low speeds required with large diameters of the piece worked.

The Commercial variable-speed motors accomplish the variation in speed by means of a double-commutator armature having two different windings, but both windings having the same size conductor or being of the same ampere capacity. A speed controller is furnished for making the necessary combination of these armature windings and for varying the field strength to secure intermediate steps between the armature combinations. These controllers are simple and compact, and the changes from minimum to maximum speed are easily and

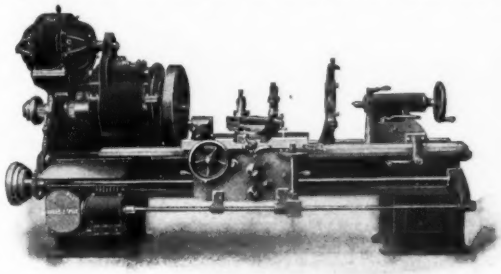
quickly effected. The controllers are made reversible.

Included in the controller is the rotary switch, by means of which the motor is started, stopped and reversed, while the speed control is set at any desired point. The speed controller and starting switch are combined into one piece of apparatus and enclosed in a neat compact case which can be placed at any desired point on a driven tool, or which can be mounted on a stand conveniently located by the side of the tool.

Among the advantageous features of this motor may be mentioned:

First. A range in speed of four to one in twelve uniformly graded steps without overlapping.

Second. The greatest torque, or pulling power, at the slowest speed, so that pieces of large diameter may be turned with as heavy cuts as smaller pieces.



COMMERCIAL VARIABLE-SPEED MOTOR DRIVING LATHE.

Third. A constant maximum horse-power at all speeds; it does not fall off in capacity at the low speeds when the greatest effort is usually required.

Fourth. A practically constant speed at all loads when the controller is set at a given point. It does not slow down when you strike a deep cut and speed up when the tool runs out into air.

Fifth. A practically constant efficiency at all speeds and a high efficiency at all loads. It wastes no power in heating resistance coils ordinarily used to control the speed.

Sixth. It can be installed on any standard two-wire or three-wire direct-current system, running from the same wires as constant-speed motors or lights already installed. It does not require a special generating plant, motor-generator set or a special system of wiring. Therefore a single machine, or any number can be installed without the consideration of an extra expense for special generators and wiring involved by other systems.

Further information regarding this electric-driving system will be gladly furnished by the Commercial Electric Company, of Indianapolis.

High-Speed Helical Gearing.

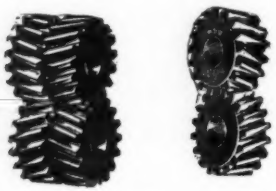
HIGH speed is one of the great desiderata of machinery designed to save labor, space and power, but the great difficulty before designers is the noise made by nearly all gearing when run fast. Some designers have made the pinion of a soft material, such as fibre or rawhide, but there are disadvantages connected with their use, and in many cases a soft material is not strong enough to transmit the power. Generally speaking, metal gears are the most practical, provided they can be cut to run without noise.

Both theory and practice indicate that the teeth of a perfect gear should not be cut in a straight line parallel to the axis, but should be cut helically, at an angle. With the ordinary straight-toothed gear, the teeth come in contact the entire width of the gear at once, exerting almost their full force with one jerk. With the helical-toothed gear, however, the action is entirely different; the power from the driving to the driven tooth steadily increases from zero to the maximum and decreases again to zero. In a straight-toothed gear the maximum amount of power, having a leverage equal to nearly the whole height of the tooth, bears upon the *top* of the driven tooth and tends to break it. But with the helical-toothed gear, the pressure does not reach its maximum until the leverage has become much less than in the case above mentioned, and this, of course, lessens the strain on the teeth. As the teeth are cut on an angle varying from twenty to thirty degrees, the teeth are from six

to fifteen per cent. longer than the actual thickness of the gear, consequently the helical-toothed gear may be of less thickness than the ordinary spur gear. For these reasons the helical-toothed gear will transmit much more power than the ordinary straight-toothed gear, and will run at very high speeds with little noise.

But the single helical-toothed gear has one disadvantage for transmitting much power. Owing to the angle of the teeth there is considerable end thrust on the shafts, varying with the amount of power transmitted. This, of course, tends to reduce the efficiency of the gears and also wastes a considerable part of the power.

To remedy this defect the gear is divided into two equal parts; one part is cut with left-hand helical teeth and the other with right-hand helical teeth, by which arrangement the end thrust is equalized.



BOSTON DOUBLE AND SINGLE HELICAL GEARS.

When using the double helical-toothed gear the teeth on one half should be placed opposite the spaces on the other half. By doing this the pitch may be made coarser and there will still be several teeth in contact.

It is necessary to have these gears cut carefully on accurate machines. It is very essential to have the teeth of the gears accurately divided around the circumference and this can be done only on first class automatic machinery, having a large index wheel. If the teeth are not accurately spaced, the entire purpose of the gear is defeated. The index on an ordinary milling machine, which is three to four inches in diameter, is usually accurate enough for straight-toothed gearing, but will not meet the requirements of the high-speed, helical-toothed gear.

The helical tooth need not be confined to gears connecting parallel shafts, but can be used to good advantage in place of bevel gears for connecting shafts which stand at right angles. It is not necessary to have these spirals cut at a forty-five degree angle, but the diameters and teeth may be varied so as to change the angle. This will, in many cases, prevent the driven shaft from turning the driving shaft when the power is released, which cannot be accomplished with bevel gears without some complicated arrangement. It is possible to make greater changes in the diameter and ratio of helical gears than of bevel gears, which is very important when the shaft centers are limited.

The designers of the high-speed turbines have realized the many advantages of these gears and are using them on their machines. The helical-toothed gears are far superior to the straight-toothed gears for transmitting steady power at low speeds as well as at high speeds. They can therefore be used universally to advantage in place of the straight form of toothed gears.

Further information concerning these gears will be gladly furnished by the Boston Gear Works, Frank Burgess, proprietor, of Boston, who have lately installed new and special machinery for cutting helical spur, or spiral-toothed, gearing.

The Lunkenheimer Metal-Melting Furnace.

THE Lunkenheimer metal-melting furnace, which is herewith illustrated, has been found to afford a very efficient and economical method of melting metals, particularly brasses and bronzes.

This type of furnace was evolved after considerable experimenting with nearly every type on the market, and is the result of considerable study. As will be seen from the illustration, the furnace consists of a cylindrical sheet-steel drum *A*, having cast-iron heads. The interior of the drum is lined with fire-proof tile, and there are two openings on opposite sides of the drum. Only one of these openings is in use, the other being closed by a fire-clay filling. The object of having two openings is to increase the life of the linings of the furnace. It has been found that the furnace wears out quicker around the filling hole (which also serves as outlet for the flame) than elsewhere. The advantage which the Lunkenheimer metal-melting fur-

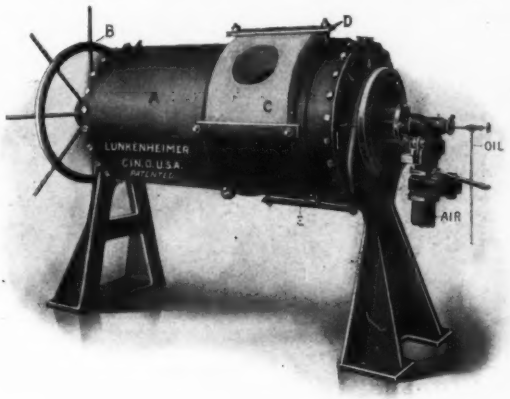
nace has over all other makes is that when one filling hole is worn out, this can be closed by a fire-clay filling and plate, the furnace reversed, and the other hole cut out and put in service.

The oil burner is of a special type, designed to give the greatest amount of heat with a minimum consumption of oil. In the Lunkenheimer foundry there are ten of these furnaces in use, and from six to seven heats per working day of ten hours from each furnace. The weight of each heat in the smaller size of furnace averages about five hundred and fifty pounds, and the oil consumption varies from two to two and one-half gallons of crude oil per hundred pounds of metal melted.

send an expert to start the furnace and take off the first heat, and instruct the furnace-room employees how to secure the best results in handling, etc. Further information will be gladly given by the Lunkenheimer Company, of Cincinnati.

New Design Roll-Jaw Crushers.

TWO new designs of the well known roll-jaw fine crushers, one of cast iron, and the other of sectional steel construction, are illustrated on the following pages. The former is remarkable for its compact, simple and massive design. It is heavy, low and immensely strong, yet all of the reciprocating parts are steel, the



LUNKENHEIMER METAL-MELTING FURNACE.

The life of the linings is from three to four hundred heats, this varying with the kind of metal melted. The whole furnace is of a heavy and substantial construction, and will be found very durable. On account of the simple form of the tile it is very easy to re-line, this operation being a difficult one in some other types of furnaces.

This furnace is made in two sizes, the No. 1 size having a capacity of five hundred and fifty pounds of metal per heat, and the No. 2 size having a capacity of twelve hundred pounds.

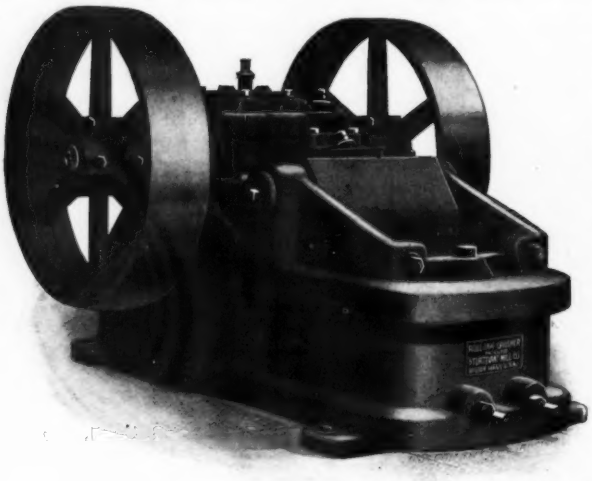
With the first furnace sold to each customer within a radius of one thousand miles of Cincinnati, the manufacturers will

comparative lightness of which greatly reduces vibrations.

The steel sectional roll-jaw crusher is probably the safest crushing machine ever produced. It has enormous strength, although comparatively light, for its steel parts are four times as strong as, although one-quarter the weight of, cast iron.

These roll-jaw crushers are not complicated. They are jaw and toggle machines of the Blake type, but are the only ones capable of a fine grade of output. The jaws, instead of advancing and receding, as in other toggle breakers, always remain the same distance apart, and thus deliver a fine and uniform product such as would come from an ordinary crusher, and two

sets of rolls. They do not clog, and the peculiar and ingenious arrangement of parts admits of a class of work unattainable in any other single machine reducing hard rock. Roll-jaw crushers are in a class by themselves, for no other breaker can be set for fine work without clogging. Jaw and toggle crushing is acknowledged to be the cheapest method of hard rock reduction, and as roll-jaw breakers take large rock and crush it fine, their advantage, when a fine output from large ore is wanted at low cost, is obvious.



STURTEVANT CAST-IRON ROLL-JAW CRUSHER.

Both of these machines and many others are shown and described in the large new catalogue just issued by the Sturtevant Mill Company, of Boston, who will be pleased to furnish any other information that may be desired.

Large Fire Pumping Station for Philadelphia.

THE desirability of providing separate mains for domestic water supply and for fire service has long been evident to those interested in fire insurance matters, and has been forcibly impressed upon the general public by the great fire in Baltimore and by the resulting discussion of a salt-water fire service for New York.

The existence of two systems of mains not only greatly diminishes the possibility of a failure of the water supply, but very often makes it possible to carry a pressure sufficient for fire protection without the need of fire engines. This is of special importance in crowded districts where fire engines are frequently subject to delay and often prove inadequate in fighting fire in modern high office buildings. While it would be possible to carry a high pressure in the regular service mains, it is entirely impracticable, not only because of the extra expense of pumping all the water at a high pressure, but also on account of the increased leakage and cost of fittings, loss of pressure, etc. Where a high pressure is maintained in separate fire mains, the individual fire protection systems of buildings may be so connected that water is always available on any floor of the tallest building.

However, it is not always advisable to maintain such a service from a municipal water-works plant, because the distance through which it would be necessary to carry the high-pressure mains might be unnecessarily great, and, moreover, an accident to the plant might disable both services. The high-pressure pumping engine would probably be of a type different from the regular service engines and little economy would be gained by placing them in the same station, further than a possible saving in attendance.

Many considerations favor locating the fire pumping station directly in the heart of the district to be protected. The character of the motive power then becomes the next consideration. If steam is used, it will be necessary to keep steam up in the boilers continuously, although the plant may be called into action only once or twice during a year. Electricity has also been pro-

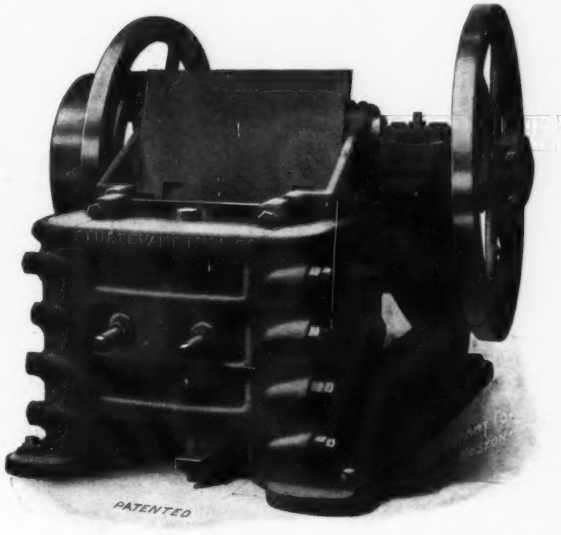
posed, and it might be advisable where connection could be had with a number of independent electric supply circuits, thus minimizing the chances of shut-down. In one of the latest plants of this character to be installed, gas engines have been chosen, the fuel supply being taken from the city illuminating-gas mains.

The installation to which we refer has recently been completed in the city of Philadelphia, and is located on the Delaware River front, at the corner of Race Street and Delaware Avenue. The district protected is bounded by Broad, Walnut and Race Streets and the Delaware River, and contains many high office buildings. The pumping station, which occupies a building 72 by 140 feet, will contain ten 11½ by 12-inch vertical, direct-acting Deane triplex pumps, each capable of delivering 1,200 gallons per minute at 40 revolutions, against a pressure of 300 pounds per square inch. There are also two 6¼ by 12-inch pumps of the same type, of 350 gallons capacity per minute. These pumps are to work together or singly, as may be desired, and all will discharge into a common 20-inch main. The water supply for the pumps will be taken directly from the Delaware River through a 36-inch suction main. Only seven of the larger pumps are being installed at present. Each of the large pumps will be driven by a Westinghouse 280-horse-power, three-cylinder, single-acting gas engine, and the small pumps by engines of the same type of 125 horse power each. The smaller engines will be direct connected to the smaller pumps through friction clutches and will also drive electric ignition generators of 7.5 kilowatts each and air compressors for supplying air at 200 pounds pressure for starting the main engines. There are three sources of current for ignition, connections with the city lighting mains and a storage battery being provided in addition to the ignition generators. The lighting current is reduced from 220 to 110 volts by a rotary transformer. Cooling water for the gas engine cylinders may be taken from two different city water mains and from the fire mains. A gas-pressure regulator on the supply pipe of each engine maintains the pressure constant.

Triplex pumps have been selected because of the even flow of the discharge, producing practically constant pressure on the discharge mains and making a very even load through all parts of the gas-engine cycle.

Each pump is fitted with a by-pass valve and a relief valve, the manner of using these valves being well described in the following clause from the specifications:

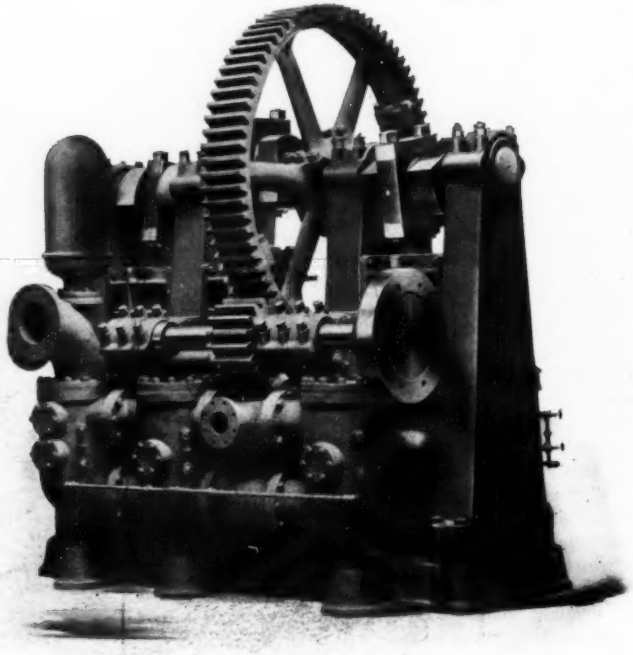
"It is proposed to maintain about sixty (60) pounds pressure on the fire mains from the city reservoir. The pumps will be started under these conditions with the by-pass open, and any surplus of water pumped will be discharged through the relief valve into the suction main. When the engine is under way the by-pass will be closed and when the water is used as fast



STURTEVANT SECTIONAL-STEEL ROLL-JAW CRUSHER.

as this unit will deliver it, its relief valve will close. In the meantime a second unit will be started and handled in the same way and so on until the full plant is in operation."

The pressure in the fire mains is controlled automatically by an electric motor acting on a valve. It may be held steadily at any point under 300 pounds, while a spring relief valve prevents it from rising above that amount.



DEANE TRIPLEX PUMP AT PHILADELPHIA FIRE PUMPING STATION.

The water ends of the pumps are divided into sections, that is, each cylinder and valve chest is a separate casting and can easily be removed by itself without disturbing the other parts of the machine. This makes a very convenient arrangement in case repairs are ever required for the water-end parts. The pumps have very large valve areas and are capable of a very much higher speed and much greater pressure than are called for in the specification.

The machines were especially designed for fire service by the Deane Steam Pump Company, of Holyoke, Mass., and are brass fitted throughout in order that they may be able to start after long periods of idleness. The pumps are very heavy in every particular and insure that every requirement on the pumping end of the equipment will be fully met.

The mains supplied by this pumping station are nine miles long and consist of pipes of 8, 12 and 16 inches in diameter. They are of extra thickness, and all fittings, including fire plugs, are of special design. The total weight of the pipe is 6,500,000 pounds and of the fittings, 850,000 pounds, costing altogether $355.555. The pump house cost $250,000, the large units, $22,000 each, and the small units $8,000. The station replaces with advantage more than 40 fire engines and as a result of its installation the rate of insurance will be reduced 25 cents per $100. Further particulars regarding this interesting plant will be furnished by the International Steam Pump Co., of 114 to 118 Liberty St., New York.

NEWS SUPPLEMENT

The Engineering Magazine—May, 1904

Coming Society Meetings.

AIR-BRAKE ASSOCIATION. Sec.: F. M. Nellis, 174 Broadway, New York. Annual meeting May 10, at Buffalo.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Next meeting Oct., at St. Louis.

AMERICAN FOUNDRYMEN'S ASSOCIATION. Sec.: Dr. Richard Moldenke, P. O. Box 432, New York. Convention June 7-9, at Indianapolis, and June 10, at St. Louis.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Annual meeting, May 17, New York. Convention, Sept. 12-17, St. Louis.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Joint meeting with the Institution of Mechanical Engineers of Great Britain, May 31 to June 3, at Chicago.

AMERICAN WATER-WORKS ASSOCIATION. Sec.: J. M. Diven, Elmira, N. Y. Annual convention, June 6 to 10, at St. Louis.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September, and November, Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Sec.: F. P. Ide, Springfield, Ill. Next meeting, May, at Chicago.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

INTERNATIONAL ELECTRICAL CONGRESS. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12 to 17, at St. Louis.

INTERNATIONAL ENGINEERING CONGRESS. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting Oct. 2 to 8, at St. Louis.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs, N. Y.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention, May 24-27, at Boston.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION. Sec.: J. C. Rockhold, Stockton, Cal. Annual meeting, Sept., at St. Louis.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. William R. Grace, ex-Mayor of New York, and president of the Ingersoll-Sergeant Drill Co, died in the latter part of March.

—Mr. William L. Saunders, who has been vice-president of the Ingersoll-Sergeant Drill Co. since 1897, has succeeded the late Mr. William R. Grace as president.

—Mr. Julian Kennedy has moved his engineering offices to the Bessemer Building, Sixth Street and Duquesne Way, Pittsburg.

—Mr. Hayden Eames, who is the selling agent for the automobile products of the

Federal Manufacturing Company, of Cleveland, has issued a little pamphlet entitled, "Will It Pay You to Change to Electric Wagons?" which contains some excellent advice for those who are contemplating a change from horse-drawn to electric vehicles.

—Mr. O. S. Kelly, president of the Kelly-Springfield Road Roller Co., of Springfield, Ohio, died recently at the age of eighty-two years.

—Mr. Rodney Strong Dennis, of the firm of Patterson, Teele and Dennis, of 30 Broad St., New York, died in March.

—Mr. Robert L. Warner has been relieved of the detail duties of management of the Boston office of the Westinghouse Electric Mfg. Company and appointed their New England manager. Mr. Warner will have general charge of their business in New England, and will be assisted by Mr. D. E. Manson, who is appointed manager of the Boston office.

—Mr. M. Greenwood, formerly Pittsburg manager of the International Steam Pump Co., has been engaged by Fairbanks, Morse & Company, of Chicago, to look after their steam pump business in Pittsburg territory.

—Mr. C. C. Starr, who was formerly connected with the firm of John Starr, Son & Company, has been engaged by the Canadian Westinghouse Company, Limited, of Hamilton, Canada, to act as their representative in the Maritime Provinces, with headquarters at 134 Granville Street, Halifax, Nova Scotia. The Maritime Provinces are included in the district of the Canadian Westinghouse Company's Montreal office, and Mr. Starr will be consequently an attaché of that office.

—Ernst J. Lederle, Ph. D., announces that he has established laboratories for sanitary, chemical and bacteriological investigations, at 518 Fifth Avenue, New York. Especial attention will be given to general building sanitation; supervision of public and private water supplies; drainage and sewage disposal systems; chemical and bacteriological analyses of water, milk, foods and commercial products; clinical investigations for physicians; and toxicological examinations.

—Mr. George J. Bancroft, Jr., well known throughout the West by his professional work as consulting engineer to the Stratton estate, as well as in other enterprises, has become associated with the Engineering Company of America and will take charge of their department of Mine Management. His headquarters will be in Denver.

—Mr. G. P. Altenberg, manager of the Foreign Department of J. A. Fay & Egan Co., the manufacturers of woodworking machinery, is on a trip, of several months' duration, through Europe.

Industrial Notes.

—On March 31 a contract for 37,000 square yards of the Bitulithic pavement was awarded by the city council of Shreveport, La., to the Nashville Roofing and Paving Company. Prior to the awarding of this contract a committee, consisting of the mayor, city engineer and other officials of the city of Shreveport, made an extended tour of investigation of the Bitulithic pavement, and in consequence of their unanimous approval an additional award of 10,000 square yards was made at a special meeting of the Shreveport city council held Monday evening, April 4. This pavement is controlled by the Warren Brothers Company, of New York and Boston.

—The Havana Construction Company, engineers and contractors of Havana, Cuba, have closed a contract for the installation of the electric light plant of the city of Guanabacoa, Cuba.

—The Pelton Water Wheel Company, after some early struggles with hydraulic problems in the introduction of their impulse wheels, have built up a business which they can regard with just pride. There are now running something more than 11,000 Pelton wheels in various parts of the world, developing altogether over 1,000,000 horse-power for electric transmission, mining, manufacturing and other purposes. In the United States alone there are about 8,800 of these wheels, with an aggregate of 811,035 horse-power, and in other countries are 2,240 wheels, totaling 278,405 horse-power.

—The Crocker-Wheeler Company, the manufacturers and electrical engineers, of Ampere, N. J., has doubled its capital stock, which has been $1,000,000. This company, which is the largest of the independent electrical manufacturers, was organized in 1892 by Dr. Schuyler Skaats Wheeler and Prof.

Francis B. Crocker, on a relatively modest basis. It now has fifteen branch offices from Boston to San Francisco, and does one of the largest businesses in the world in electric power apparatus. The capitalization was several times increased, until in 1899 it had become $1,000,000. In view of the rapidly expanding business the stockholders have now decided to increase this amount to $2,000,000.

The Lozier Motor Co., the builders of motor boats, whose offices are at 1 Broadway, New York, and whose works are at Plattsburg and Westchester, N. Y., issue an attractive and entertaining monthly publication, called *The Propeller*, the April number of which contains a project for a motor-boat trip from New York to the St. Louis Fair, views af a Lozier boat in the harbor of San Juan, Porto Rico, and pictures of recent Lozier exhibits at London, Paris and New York, and has many other interesting features.

—Wyman & Gordon, of Worcester, Mass., the manufacturers of drop forgings, have issued a short sketch of the life of Thomas Newcomen, by Dwight Goddard, as the latest number of their interesting series of brief biographies of engineers.

—The American Blower Company, of Detroit, are at present installing their "A B C" fan system of heating in the new shops of the Olds Gasoline Engine Works, at Lansing, Mich., which contract they secured because of the excellence of the lay-out submitted to the engineers of the buildings, Field, Hinchman & Smith, of Detroit.

—F. L. Smidth & Co., Engineers, have moved from William Street and Maiden Lane to the J. Monroe Taylor Building, 39-41 Cortlandt Street, New York.

—The Northern Electrical Mfg. Co., of Madison, Wis., will have an extensive exhibit in Section 14 of the Palace of Electricity at the St. Louis World's Fair.

—Beaudry & Company, of Boston, Mass., the builders of the Beaudry champion power hammer and the Beaudry duplex forging press, have moved their offices to the new Oliver Building, 141 Milk Street.

—A. Leschen & Sons Rope Co., of St. Louis, the manufacturers of wire rope and aerial tramways, have brought out a wire-rope gauge for diameters ranging from ¼ inch to 1¼ inches. This rope gauge or caliper is of celluloid and of a size which makes it convenient to carry in a vest pocket. It will undoubtedly prove useful to anyone who uses or handles wire rope, and will be sent to inquirers on application.

—The Nernst Lamp Company has recently removed its Boston office from 131 State Street to 501 Atlantic Avenue. The office will as heretofore be in charge of Mr. George C. Ewing as district manager, and will carry a complete stock of Nernst lamps and supplies, insuring prompt service to customers.

—The Chicago Pneumatic Tool Company have begun the publication of a monthly magazine devoted to the interests of pneumatic appliances and their motive power, at their general offices in the Fisher Building, Chicago. The initial number of this journal, which bears the name of *Something Pneumatic*, contains illustrated articles on the Redfield pneumatic saw, on the use of the pneumatic hammer in chipping, calking, riveting, stone working and mining, on the modern torpedo, and on other subjects, and various interesting items about compressed air and pneumatic appliances.

—The Tabor Manufacturing Co., of Philadelphia, makers of foundry molding machines, revolution counters and other engineering appliances, have opened an office at Boston, in the Mason Building, 70 Kilby Street, in charge of Mr. C. S. Lovell.

—The Cancos Manufacturing Co., of Philadelphia, the manufacturers of steam and hydraulic packings of every description, have prepared a convenient little memorandum book for engineers, which they send with trial orders of their Black Squadron ring packing. This book contains miniature maps of the United States and its island possessions, Canada, Mexico and South America, populations of cities in the United States, calendar, postal regulations, weather bureau signals, mensuration and other mathematical rules, weights and measures, data about coal, and other useful information, besides square-ruled pages for notes and memoranda.

—The Allis-Chalmers Company announce that in connection with the great extension of their business by becoming builders of gas engines, steam turbines, hydraulic machinery and electrical machinery, in addition to the classes of output for which

their several works have been for many years renowned—*i. e.*, reciprocating steam engines, pumping engines, rolling-mill engines, blowing engines, mining machinery, flour-mill machinery, saw-mill machinery, rock-crushing machinery, cement machinery, perforated metals, etc., etc., they have organized a Department of Publicity, of which Mr. Arthur Warren, who is well known in this field, has been appointed manager. They request that all communications referring to publicity in any form connected with the Allis-Chalmers Company, including the Bullock Electric Manufacturing Co., which they have acquired, will be for the future addressed to The Department of Publicity, Allis-Chalmers Company, Milwaukee, Wis.

—The New Jersey Foundry & Machine Co., of 9-15 Murray Street, New York, have issued a collection of facsimile letters from the principal manufacturers of coach screws and lag screws, in which these manufacturers say that they have agreed to use a standard thread which shall fit the Diamond expansion shield made by the above company. These standard threads are 5-16-inch diameter, 9 threads per inch; ⅜-inch diameter, 7 per inch; ½-inch, 6 per inch; ⅝-inch, 5 per inch; ¾-inch, 4½ per inch.

—The Maxfield-Francke Co. have removed their offices from 120 Liberty Street to the Electrical Exchange Building at 136 Liberty Street, New York, where they will be glad to give prompt attention to inquiries concerning the Francke four-ported steam engine and their other specialties.

—The New York Agency of the Grand Trunk Railway System are now occupying what is one of the handsomest railroad offices in the world, on the ground floor of the new Dun Mercantile Agency Building, at 290 Broadway, New York. The floor is finished throughout in Sienna marble, bronze and plate glass, these decorations costing the owners of the building $100,000, and it is considered the finest display of this handsome stone in America. The Grand Trunk leased the entire floor and called it the "Railway Exchange," having as subtenants: Great Eastern Fast Freight Line, Lehigh Valley Railroad Co., Maine Steamship Co., Clyde Steamship Co., Queen & Crescent Route, Louisville & Nashville Railroad Co., Wisconsin Central Railroad Co., Central Railroad of New Jersey, The Central States Dispatch, Pere Marquette Railroad Co., Georgia Railroad Co. The consolidation of these interests is a new departure, and in the brief time that they have been together it has operated to so much advantage to the roads interested, and has been such an accommodation to the shipping and traveling public that its success is assured.

—The Philadelphia office of the B. F. Sturtevant Company has just placed an order for fifty of "The Reeves" variable-speed transmissions, with the manufacturers, the Reeves Pulley Company, of Columbus, Ind. The order was placed through the Philadelphia agent of the Reeves Pulley Company, Mr. W. R. Shipley. The Sturtevant Company are using "The Reeves" transmission on their rotary cement kilns and coal conveyers.

—The John Davis Company since January 1st, 1904, have installed the following large sizes of the Hochfeldt Eclipse back-pressure valves, and each and every one is giving the very best satisfaction: four 14-inch, two 20-inch, four 12-inch, two 16-inch, one 24-inch, one 30-inch, two 10-inch.

—The F. W. Braun Co., of Los Angeles, Cal., propose to have a very complete and interesting exhibit of goods of their manufacture at the St. Louis Exposition this summer, including all of their patented labor-saving devices for laboratory use, such as crushers, pulverizers, crucible and muffle furnaces, bullion-melting furnaces, laboratory cyanide plants, gasoline, crude oil and illuminating gas burners, blowpipe outfits, etc. Their display will be located near the southwest corner of the Mines and Metallurgy Building.

—The Patterson Tool & Supply Co., of Dayton, O., have brought out a folding circular which gives a very good representation of a case filled with drawing instruments.

—Advertising managers representing various prominent manufacturies in Cleveland recently formed an organization for mutual benefit, to be known as the Manufacturers' Advertising Club. Meetings will be held monthly, and at each meeting an address will be delivered by an advertising expert. At the meeting on April 12th, Mr. Boyd, of The Curtis Publishing Co., was the speaker. The officers of the club are: President, Mr. Charles B. Shanks, of The Winton Motor

Carriage Co.; vice-president, Mr. William Townsley, Jr., of The Grasselli Chemical Co.; secretary, Mrs. F. A. McIntosh, of The Standard Tool Co.; treasurer, Miss E. L. Harmon, of The Loew Supply & Mfg. Co. The membership of the club excludes advertising solicitors and brokers.

—The fourth annual sessions of the Summer School for Artisans, held under the direction of the College of Engineering of the University of Wisconsin, begins June 27th, and continues for a period of six weeks. Courses of study are offered in the following subjects: 1. Steam, gas and other heat engines: Lectures on the theory of heat, the operation and methods of testing steam, gas and air engines, boilers, compressed air and refrigeration plants. 2. Applied electricity: Theory of direct and alternating current dynamos and motors, the operation and methods of testing electrical machinery, batteries, transformers and other apparatus, photometry, and calibration of instruments. 3. Mechanical drawing and machine design: Elements of applied mathematics, courses in mechanical drawing and machine design adapted to the preparation of the students. 4. Materials of construction, fuels and lubricants: Lectures on the properties of materials, accompanied by laboratory tests; lectures on fuels and lubricants with laboratory tests on the heating value of coals and efficiency of lubricants. 5. Shop work: Practice with hand tools, wood and metal-working machinery, and in blacksmithing and pattern making. The instructional force is taken from the regular faculty of the College of Engineering, and the entire laboratory and shop equipment belonging to the college is used by the students in the Summer School. The requirements for admission do not extend beyond a working knowledge of English and arithmetic, but the policy is to allow a large amount of individual work so that the student may take advantage of all the preparation he has obtained. As the demand renders it necessary, advanced courses will be established in the various subjects. This school offers to those unable to take a regular four-year course, an opportunity of obtaining practical working knowledge of the methods of testing and the use of instruments, together with such theoretical principles in each case as the nature of the subject and preparation of the student may permit. A bulletin describing the work of the School for Artisans in detail will be sent on application to Frederick E. Turneaure, Dean College of Engineering, Madison, Wis.

—In the beginning of 1901 the Society of German Engineers (Verein Deutscher Ingenieure) began the compilation of a universal technical dictionary, called the "Technolexikon," in the three languages: English, German, and French. This undertaking has met with general approval and has received assistance from all quarters at home and abroad. Societies and individuals have responded generously to the invitation to collaborate and have proved their interest by the transmission of collections of technical words made by them, or by promising such in the near future. Up to the present, there are 363 societies (51 in English, 274 in German and 38 in French speaking countries) co-operating in the work, either by the systematic collection of technical expressions of the specialties represented by them, or in other ways, especially by the acquisition of collaborators and by placing technical publications in more than one language at the disposal of the "Verein," such as catalogues of firms, inventories, piece-lists of machines, handbooks, &c. For convenience sake the Society of German Engineers has provided handy note-books for the collaborators to write their collections in and so far 317 filled-out note-books have been forwarded voluntarily to the office at the address given below. Contributions from all technical branches (including the handicrafts) are welcome, and it is obvious that small contributions from a host of various collaborators will be more useful than large ones compiled by a few men, who naturally cannot cover so many specialties. Attention is to be drawn to the fact that contributions in only one language are also acceptable. The note-books are now being called in, but important contributions may be made use of in exceptional cases if they are received before printing begins, which will be about June, 1906. The editor-in-chief will be pleased to give any information wanted. Address: Technolexicon, Dr. Hubert Jansen, Berlin (N W. 7), Dorotheenstr, 40.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Alternators.

Catalogue No. 60, containing descriptions, half-tone illustrations, diagrams and tables of data of alternating-current generators with revolving fields and stationary armatures, and other alternating-current machinery for lighting, power and railway service. 9 by 6 in.; pp. 40. National Electric Company, Milwaukee.

Air Engine.

Pamphlet containing a reprint of an article from *The Iron Age*, which gives an illustrated description of the Pilling air engine, built on the lines of the oscillating steam engine, and its application to hoisting and other purposes. 8 by 6 in.; pp. 8. Pilling Engine Works, Bucyrus, Ohio.

Ball Bearings.

Booklet with illustrations and description of the American compound bearing, or Chapman double-ball bearing, for automobiles, bicycles and vehicles of every description, shafting, engines and all kinds of machines. 3½ by 6 in.; pp. 4. Also, facsimile testimonials from users of these bearings, showing their great efficacy in reducing friction to a minimum. American Compound Bearing Co., 25 Broad St., New York.

Blowers.

Catalogue No. 30, with illustrations and descriptions of volume blowers and exhausters for all purposes, which are adjustable, reversible and interchangeable, and may be placed on either the floor, the ceiling or the wall. 9 by 6 in.; pp. 16. The Indiana Fan Company, Indianapolis.

Blue-Printing Machines.

Catalogue, containing description and illustrations of the Federal blue-printing machine, which employs a transparent apron, can be run at any speed desired, takes any size print, permits prints and tracings to be easily fed to it, and may be used with either sunlight or electric light. 9 by 6 in.; pp. 12. Spaulding Print Paper Co., Inc., Boston.

Card Systems.

Catalogue, with illustrations, descriptions and prices of index cards, guide cards, pocket card-index outfit, card cabinets, card boxes, vertical-file folders, cases and cabinets, sectional cabinets and bookcases, desk portfolio, transfer cases, desks, chairs, and all kinds of index and filing devices. 10 by 7 in.; pp. 22. Koller & Smith, Port Richmond, N. Y.

Castings.

Booklet, folder and card devoted to Franklin finished castings, which are die-cast in steel molds, and are then completely ready for assembling in a machine. These castings comprise gears and all kinds of small parts, of any degree of complication. 6 by 3½ in.; pp. 12. H. H. Franklin Mfg. Co., Syracuse, N. Y.

Condensers.

Catalogue D, containing illustrated descriptions of twin vertical air pumps and condensers, guaranteed to produce the highest vacuum by mechanical means, for marine and stationary steam engines and for salt, sugar and chemical works. 6 by 3½ in.; pp. 12. Great Lakes Engineering Works, Detroit.

Crushers.

Large catalogue, with illustrated descriptions of gyratory crushers, of great capacity and economical operation, for rock, ore and similar materials, screens, dump cars, dump carts and stone-spreading wagons, and plans and views of crushing plants. 7½ by 10¾ in.; pp. 84. Austin Mfg. Co., Chicago.

Electric Heating.

Catalogue, with descriptions and illustrations of electric cooking utensils, glue pots, soldering irons, instrument sterilizers, radiators, laundry apparatus, and many other electric heating appliances, for use on shore and on shipboard. 8 by 5 in.; pp. 82. Simplex Electric Heating Company, Cambridge, Mass.

Electric Machines.

Bulletin No. 148, illustrating and describing a new line, termed type "S," of direct-current dynamos and motors, both open and enclosed, and in floor, ceiling, wall and vertical styles, with their details and tables of dimensions. 10 by 7½ in.; pp. 12. The C & C Electric Co., 143 Liberty St., New York.

Electric Motors.

Circulars Nos. 1077 and 1078, devoted, respectively, to direct-current, series-wound motors for cranes, hoists and other intermittent service requiring a large starting torque, and to single-phase alternating-current railway motors and car equipment, with illustrations and diagrams. 10 by 7 in.; pp. 20 and 12. Westinghouse Electric & Manufacturing Co., Pittsburg.

Bulletins Nos. 1002 A and 1023, devoted, respectively, to Type "N" direct-current, multipolar motors, especially designed for direct connection to machine tools, and to Type "B" direct-current motors, constructed to withstand rough usage, with illustrations of motors and their parts, and motor-driven machines and tools, diagrams and dimension tables. 9 by 6 in.; pp. 28 and 12. Bullock Electric Mfg. Co., Cincinnati.

Bulletin No. 35, containing profusely illustrated descriptions of multipolar direct-current electric motors and their details, in many different styles, for driving tools and machinery of all kinds. 10 by 6¾ in.; pp. 36. Also, leaflets devoted to generators in lighting service, and motors operating Coffin hydraulic sluice valves, emery grinders and machine tools. Northern Electrical Manufacturing Co., Madison, Wis.

Electric Supplies.

Perpetual catalogue, made up in bulletin form, containing illustrations and descriptions of electric pole-line materials, arc-light mast arms and pulleys, switches, circuit breakers, fuses, lightning arresters, transformers, arc and incandescent lamps, brackets, electroliers, rheostats and controllers, telephone booths, primary batteries, and a great variety of other electrical supplies and machinery. 10 by 7½ in. The F. Bissell Company, Toledo, O.

Expanding Tools.

Catalogue, containing descriptions and illustrations of the Lovekin new and efficient tools and machinery for expanding and flanging iron, steel and copper pipe of all sizes, and for expanding valve seats in gate, globe and angle valves. 9 by 6 in.; pp. 36. Also stock list of a great variety of tools and appliances and iron and steel supplies. 7 by 4½ in.; pp. 144. Scully Steel & Iron Co., Chicago.

Expansion Bolts.

Price list and illustrated descriptions of Church's patent expansion bolts for fastening all kinds of structure to brick, stone and cement work, expansion awning and shutter hinges, expansion screw eyes, anchor and toggle bolts, and other fastenings. 6 by 3¼ in.; pp. 12. Isaac Church, Toledo, Ohio.

Fireproof Construction.

Large pamphlet on the fires at Baltimore and in the Iroquois Theatre, Chicago, containing a description of the effects of the fire upon various materials employed in modern fireproof buildings, with remarks on the lessons of the fires and recommendations for future construction, and with many handsome illustrations. 9 by 10 in.; pp. 62. The Roebling Construction Company, Broadway and 23rd St., New York.

Lubricators.

Catalogue No. 9, containing illustrations, descriptions and prices of sight-feed lubricators, glass and brass oil cups, oil pumps, grease cups, water gauges, gauge cocks, throttle valves, dynamo and motor oil gauges, boiler oil feeders, and other devices for lubricating cylinders, bearings and engines. 10¼ by 7¾ in.; pp. 108. Michigan Lubricator Co., Detroit.

Machine Tools.

Very large and comprehensive cloth-bound catalogue, profusely illustrated with half tones, and containing views of the various works of the Niles-Bement-Pond Company, reproductions of medals and diplomas awarded them, and descriptions of lathes, planers, boring and turning mills, boiler-shop machinery, hydraulic presses and riveters, steam hammers, electric traveling cranes, small tools, and many other kinds of machine tools. Metric as well as English dimensions are given, and there is a complete index. 12 by 9 in.; pp. 713. Niles-Bement-Pond Co., 136-138 Liberty St., New York.

Oil Separator.

Catalogue No. 14, describing and illustrating the Austin "special" oil separator for extracting oil from exhaust steam, operating under a vacuum, or otherwise, and delivering pure, distilled water of condensation, and particularly adapted to large steam plants. 8 by 5¾ in.; pp. 12. Austin Separator Co., Detroit.

Pneumatic Hoists.

Catalogue, containing descriptions, illustrations and prices of pneumatic motor hoists, cylinder air hoists, trolleys, winding drums, foundry elevators, car jacks, jib cranes and other pneumatic hoisting machinery. 9 by 6 in.; pp. 32. Chicago Pneumatic Tool Co., Chicago.

Shapers.

Catalogue C, containing half-tone illustrations and descriptions of various styles of crank shapers, rack shapers, and traverse shapers, the latter with single and double heads and with swivelling saddle, designed for machining both ends of a steel beam at one time. These shapers are either belt driven or connected to electric motors, and embody many special features with all the latest improvements. 6 by 9 in.; pp. 45. The Cincinnati Shaper Co., Cincinnati.

Silicate Stone.

Pamphlet, containing descriptions and illustrations of Ford's patent silicate-of-lime building stone, in very large or small blocks, bricks, tiles and paving slabs, with results of highly satisfactory compressive, tensile, weathering and chemical tests. 11 by 8 in.; pp. 8. Silicate Stone Co., 39 Wall St., New York.

Steam Engines.

Catalogue No. 55, containing half-tone illustrations and descriptions of Corliss engines, simple and compound, belted and direct-connected, with girder, Tangye and rolling-mill type frames, and of air compressors, fire-tube and water-tube boilers, feed-water heaters and complete power plants. 7 by 9 in.; pp. 62. Murray Iron Works Co., Burlington, Iowa.

Steam Receivers.

Booklet describing and illustrating the Simonds improved steam receiver and separator for storing the steam near the cylinder and separating the entrained water and foreign substances from the steam, and containing an interesting discussion of some points that are often overlooked in designing steam plants. 6 by 3¼ in.; pp. 16. Frank A. Simonds, Grand Rapids, Mich.

Thermometers.

Illustrated pamphlet, giving an account of the making of thermometers, and describing a thermometer, or thermo steam gauge, and pocket for process kettles used in the canning industry. 7 by 5½ in.; pp. 10. The Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Wire Rope Tramways.

Catalogue, containing descriptions and illustrations of automatic aerial wire-rope tramways on the double-rope, single-rope, two-bucket, one-bucket, excavator and special systems, for mining work, lumbering and other purposes, hoisting and conveying cableways for logging, quarrying, coal handling, placer mining and construction work, and incline railways. 9 by 6 in.; pp. 34. Hallidie-Painter Tramway Co., San Francisco.

IMPROVED MACHINERY

New Processes and Appliances

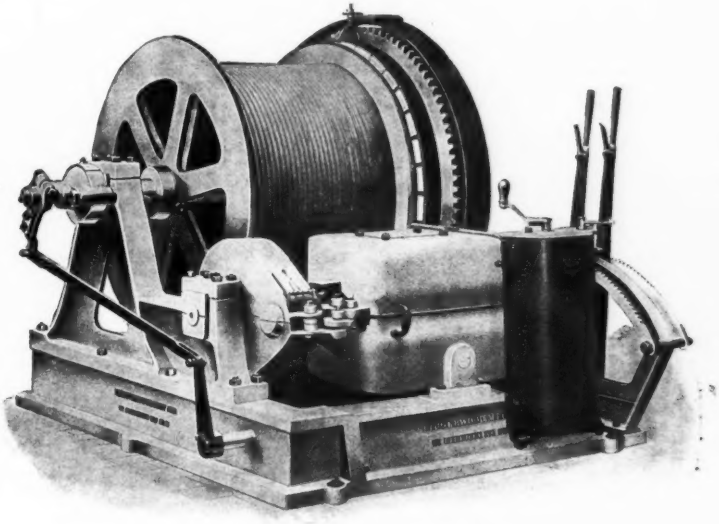
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Lidgerwood Electric Mining Hoist.

ENGINEERS generally will find much to admire in the machine herewith illustrated, which is the latest Lidgerwood direct-current electric mining hoist. It is designed for use with current of 500 or 250 volts potential and embodies in its construction the various features of excellence characteristic of all Lidgerwood hoists.

The friction drum is of the standard Lidgerwood form, equipped with all the latest patented improvements.

The motor, which is made by the General Electric Co., is of the armored type and especially adapted for hoisting purposes. All the moving parts are protected from dust and moisture by suitable casing, and the cut gearing from the motor to the intermediate shaft is enclosed in an oil-tight case.



LIDGERWOOD ELECTRIC MINING HOIST.

The drum motor and controller are mounted complete on a bed plate. The resistance boxes are usually separate from the hoist, being conveniently located so that the heat generated may not be annoying to the operator. In smaller sizes it is sometimes desired to have the machine completely self-contained and portable, in which case the resistances are of special form and attached to the inside of the bed plate.

The drum gearing is cast from standard patterns and is protected by means of the usual guard band. The controller, which is of the railway type, is provided with a reversing switch, and mounted so as to be most convenient for the operator.

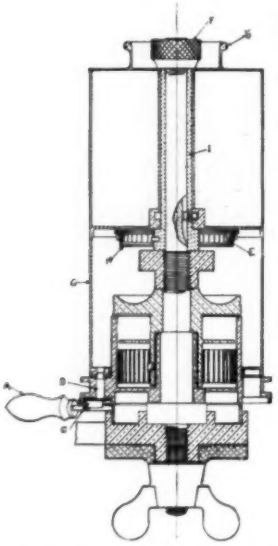
The friction and brake levers are mounted in a rack with notched quadrants and are fitted with thumb-latches.

A large number of these electric mining hoists have been built, in every instance giving complete satisfaction, and any further information concerning them will be gladly furnished by the Lidgerwood Mfg. Co., of 96 Liberty Street, New York.

Improved Detent Motion for Thompson Indicators.

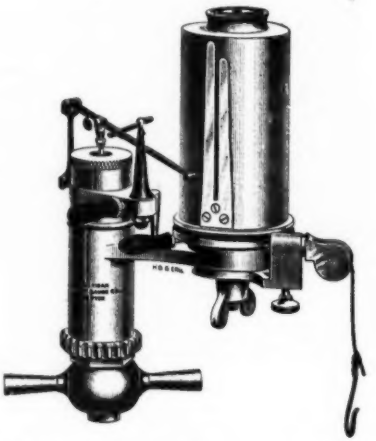
IN taking indicator diagrams from high-speed engines it is sometimes very difficult to take off one card and put on another, for the reason that the movement of the drum carriage must be stopped while changing the card, or while the drum is removed and put on again. This stopping and starting of the drum carriage of the ordinary indicator, whenever it becomes necessary to put on a new card, however accomplished, is usually attended by much inconvenience.

These difficulties are wholly overcome by using the improved detent motion shown in the accompanying cross section, as the drum



SECTION OF PAPER DRUM, SHOWING DETENT MOTION.

carriage, after it is once connected with the reducing motion, need not be disconnected until desired. In taking cards from locomotive and marine engines it is usually much more difficult to connect and disconnect the drum carriage with the reducing motion than it is with stationary engines. In taking cards from marine engines it is often



THOMPSON INDICATOR WITH IMPROVED DETENT MOTION.

very desirable or even necessary, on account of close quarters and heat, to take the drum off the indicator in order to put on a new card, and this results in the spoiling of the fit of the drum of the ordinary indicator, and thereby causing it to run out of true, a very objectionable feature, which the new detent motion entirely obviates, as the drum fit on the spindle is a long, lubricated bearing well adapted for wear.

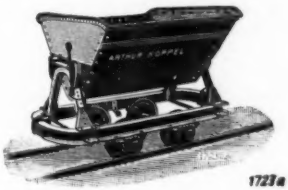
In operating the detent drum stop motion, to stop the motion of the paper drum, move the lever A in the direction traveled by the paper drum until the drum releases itself, then return the lever to its place. When ready to take the diagram, turn the paper drum by means of the milled rim B on top forward until it catches, causing the drum to revolve in the usual manner; then take the diagram and release the drum as described above. Before taking the diagram, see that the parts are cleaned and well oiled. To oil, remove the knurled nut F, take off the paper drum, then with the wire clip (which is sent with each indicator), remove the auxiliary spring case H by catching the end of the clip in the notches of the spring case, turn it forward until it releases

from the catches, then remove the spring and inner sleeve I. After cleaning and oiling, replace the inner sleeve I by inserting it into the drum so that the pin on the outside of the sleeve will enter the slot inside of the drum bearing, and turn it until it comes to stop; then with the wire clip catch hold of the auxiliary spring holder H and give the auxiliary spring E a tension of about one-quarter turn, and catch the points on the spring case H into the slots provided for them.

Further information about this detent motion and also about the whole American Thompson improved indicator may be procured from the makers, The American Steam Gauge and Valve Manufacturing Co., of Boston.

Railways for Manufacturing Establishments.

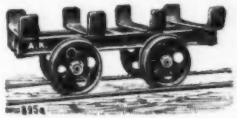
EVERY intelligent manufacturer seeks to reduce his labor cost and is always alert to discover and install new appliances adapted to secure this end. In transporting



KOPPEL CAR.

materials in process of manufacture, distributing coal to furnaces, and removing ashes and waste of all kinds, there is much to be learned from the manufacturers of light railways. One of the largest manufacturers of these railways and of the cars that run over them is the firm of Arthur Koppel. This concern was one of the first to manufacture cars for industrial works on a large scale and subsequently to specialize the manufacture of these cars. The requirements of every large industry have been studied, and cars of special design or with special devices for loading and unloading have been constructed. Similarly, ingenious devices have been designed in the way of turntables, turnouts, switches, and crossings, so that the most use can be made of tracks when laid.

The accompanying illustrations show some of the cars of special design. All of the cars made by this firm have special running gear, enabling them to be moved easily and operated in contracted and crooked places. The tracks are so built as to present the least possible obstruction. The aim in all directions is to facilitate and economise in the handling of heavy or bulky

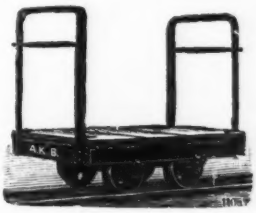


KOPPEL CAR.

objects. The catalogue of Arthur Koppel of 66 and 68 Broad Street, New York, shows the great diversity of product made and will be sent on request, but it is not the last word in the business, as the firm is always ready to devise a plant to meet special conditions or for new purposes, and will be pleased to supply any further information that may be desired.

The Warner Magnetic Cut-Meter.

WITH the modern improvements in tool steels and machine tools it is possible to effect great economies in manufacturing, but in order that a shop may be operated at its highest efficiency, it is necessary that each tool be run at the speed proper for the material it is working on and the cut it is taking. It is practically impossible to determine this speed by eye, and so a device which will indicate accur-



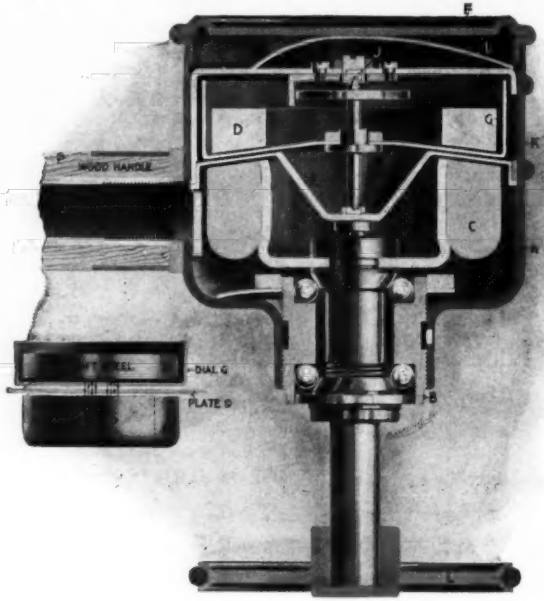
KOPPEL CAR.

ately how fast tools are running is eminently desirable.

Such an instrument is the Warner cut-meter shown in the accompanying illustrations. It consists essentially of a perman-

ent magnet attached to a wheel, and an aluminum disc in which electric currents are induced when the magnet moves. As the magnet rotates, it tends to drag the aluminum disc with it, and this motion of the disc being resisted by a hair spring, the disc will be displaced from its normal position by an amount depending upon the speed of rotation of the magnet. By suitably marking the edge of the disc this speed can be read directly.

In the cross section of the instrument shown, the magnet C is carried by the ball bearing B, the outside of which is threaded and screws into the outer case A. The ball bearing is secured by a spring washer, and can be turned only with a specially shaped wrench, as it is not intended to be moved except by the manufacturers. In front of the magnet is a soft steel ring D, which deflects the lines of force through the aluminum disc G. This disc is mounted on a hardened-steel shaft and is supported by the jewels J. On the outside edge of the aluminum disc are engraved the figures indicating the speed. Also attached to the shaft is a hair spring H, so adjusted that it resists the turning of the aluminum dial and brings it back to the zero point when the magnet is at rest. The jewel bearings and the steel ring are carried by the inner case E which telescopes into the outer case and can be removed at will. The inner case also serves the purpose of protecting the dial G from the air currents set up by the magnet when revolving. In both outer and inner case is an opening, covered by a glass K, through which the figures on the aluminum dial can be read. Attached to the main shaft is the driving wheel, or disc L,



CROSS SECTION OF WARNER CUT-METER.

of proper diameter, having a hollow or gutter-shaped periphery into which is snapped a miniature rubber tire M.

When the magnet is rotated it induces electric curents in the disc or dial G, and so causes it to revolve by a force which is proportional to the speed of the magnet. The resistance of the hair spring being subject to the same law, it is evident that increasing the speed of the magnet will increase the displacement of the dial in exact proportion. The dial or scale can therefore be marked by equal divisions from the lowest to the highest reading. Since ad-

justing the magnet closer to the steel ring increases the torque, or dragging effect, it is only necessary to select a hair spring of proper stiffness, and to revolve the magnet at a known speed, at the same time adjusting the ball bearing until the scale indicates the correct speed. The instrument will then be accurate on the entire range of the scale

WARNER CUT-METER.

and will remain so permanently, there being no necessity for subsequent adjustment or recalibration. The magnets are very carefully prepared and tested, so that there can be no doubt as to their permanency. As there are no mechanical connections between the magnet and the indicating dial, and as the magnet runs very easily, there being always an abundance of power to drive it, there can be no possible inaccuracy up to this point.

The indicating dial is mounted on a steel shaft, the points of which are hardened and supported in sapphire jewels, practically eliminating all friction or retardation. How perfectly this is accomplished can be judged from the fact that a change in speed of one-fifth of one per cent. is shown on the dial. It should not be thought that because this disc is mounted on jewels that the instrument is a delicate one, requiring careful handling. Since the dial and shaft are very light, the strength of the jewels and pivot is amply great in comparison to the weight, and experience has shown that they will stand the regular service likely to be given in any ordinary machine shop.

The instrument is so small and light that it can be carried in the pocket without inconvenience. It presents a very handsome appearance, being substantially constructed of brass and nickel plated. The handle is turned from a hard tropical wood and is highly polished.

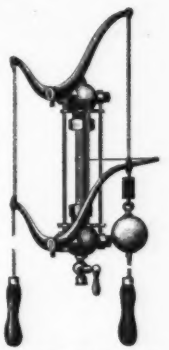
By placing the rubber-tired wheel against any moving machine or piece of work the speed will be indicated directly, in feet per minute, or any other desired units, and it is evident that this instrument is available also for a number of other uses besides determining the cutting speeds of machine tools.

Further information will be gladly given by the manufacturers, The Warner Instrument Company, of Beloit, Wis.

Self-Closing Water Gauge.

IT is a well-known fact that the water glass is the weakest point on a boiler and any appliance that will protect that point must necessarily be a valuable addition.

If the water glass breaks, the water is blown out, and if there is fire under the boiler, as is generally the case, unless the gauges are closed the boiler will be ruined. In many instances valuable property has been destroyed in this way, and engineers and firemen have been seriously scalded, as it is often impossible to shut off the steam and water without getting injured.



CUNNINGHAM SELF-CLOSING WATER GAUGE.

It becomes, therefore, of the greatest importance to provide a means for automatically shutting off the water glass from the boiler, in case of accident, and such a device is embodied in the Cunningham auto-positive, self-closing water gauge, shown in the accompanying illustration.

Its motive power is gravitation, which is infallible. Unlike other appliances of this kind, there is nothing to obstruct the flow of water to the glass, which is very important. Boiler scale or corrosion cannot interfere with it.

Valves on the upper and the lower part of the water gauge are held open by a wire, which runs from the glass to the rod on the lower lever. When the glass breaks, this support is removed, the result being that the weighted ball instantly drops, so closing both valves.

The apparatus admits of being "tried" at all times by the operator, by simply rocking the levers slightly, without disarranging its parts, thereby insuring its work positively. If the glass cracks enough to let out steam or water that would injure the attendant or boiler, instead of flying into a thousand pieces, as it does in ninety-nine cases out of a hundred, the ball is of sufficient weight to pull out the glass and shut off the cocks instantaneously.

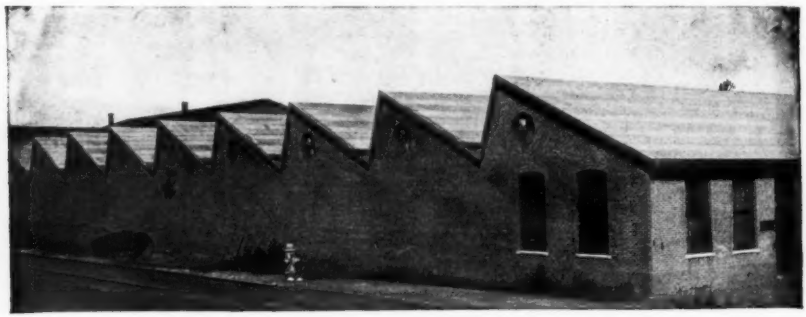
This device is especially adapted for high-pressure service, on locomotive boilers, in separators, where a man is close to the glass when it breaks, on acid tanks, and on gauges in out of the way places, which are inaccessible. Even on low-pressure and house-heating boilers and expansion tanks, where incompetent persons are in charge, and on boilers that are left over night with no attendant, glasses are liable to break and do great damage before the water or steam can be shut off, and such an automatic device is of great value.

Further details concerning this apparatus will be gladly furnished by the makers, the Standard Gauge Manufacturing Co., of Syracuse, N. Y.

Granite Roofing.

SOME of the recently constructed shops designed for manufacturing purposes have had provision made for adequate day lighting by the construction of saw-tooth windows over certain portions of the roof. These windows, by their arrangement, not only provide for the admittance of an abundance of light, but are often used as a means of securing proper ventilation.

Where climatic conditions include possible heavy falls of snow, the great question is to obtain roofing material for this form of structure that will withstand the severe conditions imposed, particularly in the trench portion, where it is necessary that the roof be made waterproof for some distance from the bottom in order to avoid leakage and damage from snow and water. At other times, the heat of the sun will cause gravel and ordinary composition roofings to run on steep roofs of this class.



PITTSBURG AND LAKE ERIE R. R. SHOP WITH GRANITE ROOFING.

These troubles may be avoided by the use of a material known as perfected granite roofing, which, taking into consideration its ease of application, its sightliness, its fireproofing qualities, and its low price, seems to be the most suitable composition roofing for saw-tooth buildings.

The roof of the machine-shop section of the new locomotive and car shops of the Pittsburg and Lake Erie Railroad, at McKees Rocks, Pa., is a saw-tooth structure and is covered with this material, under a ten years' guaranty.

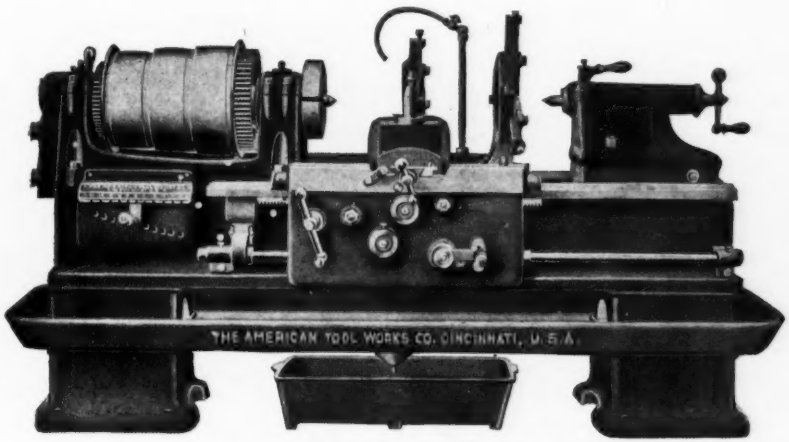
This roofing material is not new on the

market, having been extensively used for years by many of the largest railroads and manufacturing corporations. It is made by the Eastern Granite Roofing Co., of New York, who will furnish any further information that may be desired.

High-Speed Lathe.

THE high-speed manufacturing lathe shown in the accompanying illustration, which is the very latest tool brought out by the American Tool Works Co., is of particular efficiency in turning up shafts of small diameters. It is given an unusual amount of strength in all its parts, in order to adapt it to the very heavy requirements which progressive manufacturers demand in a tool of this character. The bed is made extra deep and wide, and is supported by substantial cabinet legs. The apron and carriage are given extra strength. The apron is powerfully geared, with longitudinal and cross-feed friction. The patent drop V pattern of the bed makes it possible to place a great deal of extra metal in the bridge of the carriage, usually a point of weakness in a lathe. The headstock is made extremely rigid, and is equipped with a cone of three steps, all of large diameter, for 4-inch double belt. This endows the lathe with a very great amount of belt power, so much so that the contact of belt when on the smallest step of the cone, is greater than on the ordinary 36-inch lathe. The lathe being intended primarily for working at very high spindle speeds, the bearings are of unusual size, made of phosphor bronze, and scraped to a perfect fit.

In the illustration the entire screw cutting mechanism of the lathe is omitted, because of the character of the customer's work. This mechanism can, of course, be included when desired, and is similar to that incorporated on the regular "American" lathe, with a range of forty-four changes immediately available while the machine is in full operation without removal of a single gear. The leadscrew is located on the inside of the bed directly under the cutting tool, which thus centralizes the strain and obviates all twisting tendency, common in lathes where the screw is on the outside, pulling through the apron. This lathe can also be equipped, as shown, with a means of constant and effectual oil supply to the cutting tool, together with a large pan of symmetrical appearance, for catching oil and chips.



"AMERICAN" HIGH-SPEED MANUFACTURING LATHE.

This high-speed lathe is at present built in one size with an actual swing of 20 inches. Further details going into full particulars regarding the machine and describing recent remarkable tests performed with it, will be cheerfully furnished by the makers, the American Tool Works Co., of Cincinnati.

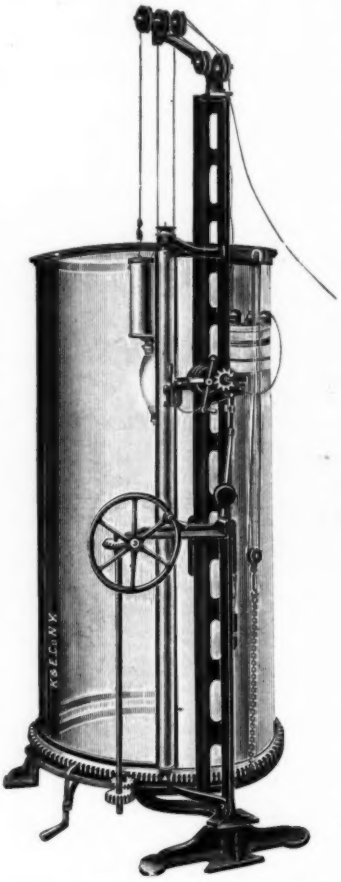
Vertical Cylindrical Electrical Print Frames.

BLUE-PRINTING by electric light possesses many advantages over the older methods which employed the actinic action of sunlight, and some of the largest companies have had electric printing machines installed as part of their drawing-room equipment.

One of the best and most up-to-date of these machines is shown in the accompanying illustration.

This cylindrical apparatus consists of two sections of curved glass, each mounted in a metal casing and together forming a cylinder which rotates on a circular base. It requires a floor space of about 36 by 42 inches. The lamp is suspended in the axial line of the cylinder, up and down which it travels, driven by a clockwork mechanism.

Tracing and paper are placed on the outer surface of the glass cylinder, where they are held by a canvas curtain mounted on a vertical roller attached to the upright which carries also the lamp and the mechanism for moving it. This curtain is wound on to the cylinder by rotating the cylinder on its base, which is done by a conveniently placed handwheel. It is held tense by the roller spring and a foot brake on the base plate, which arrests the cylinder. The rotating of the cylinder therefore automatically winds the curtain on to it, and holds the tracings and paper in very good contact. The feeding in of the tracing and paper is easily and quickly accomplished, and there is no tilting of the glass cylinder. The unwinding of the curtain is done by means of the handwheel, assisted by the spring acting on the curtain roller.



KEUFFEL & ESSER VERTICAL CYLINDRICAL ELECTRICAL PRINT FRAME.

The lamp is of a special pattern to give perfect diffusion and distribution of light. It is moved by clockwork and can be set to any required speed, to any distance of travel, and to start from and stop at any point. The current is cut off automatically at the end of the travel of the lamp.

This is a very economical apparatus because it requires only one lamp, even for large tracings. Tracings and paper can be inserted and removed very quickly and conveniently. It is much less liable to accidental breakage than the similar cylinders which swing in pinions and are placed horizontal to be loaded, and it requires less floor space.

These frames can be furnished with lamps for either direct or alternating current, 110 or 120 volts and are furnished all complete, ready to connect with the feed wire.

Provided with such a machine, a drawing department becomes independent of the state of the weather and can get out its blue prints at any hour of the day or night, and can easily satisfy rush orders from the shop. As above stated, the speed of printing can be regulated, and exposures can be timed to a nicety.

These machines will be supplied from stock at short notice by the manufacturers, the Keuffel & Esser Company, of 127 Fulton Street, New York, who will gladly give any further information concerning them which may be desired.

NEWS SUPPLEMENT

The Engineering Magazine—June, 1904

Coming Society Meetings.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Next meeting, Oct. 4-6, St. Louis.

AMERICAN FOUNDRYMEN'S ASSOCIATION. Sec.: Dr. Richard Moldenke, P. O. Box 432, New York. Convention June 7-9, at Indianapolis, and June 10, at St. Louis.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Convention, Sept. 12-17, St. Louis.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

AMERICAN PARK AND OUTDOOR ART ASSOCIATION. Sec.: C. M. Robinson, Rochester, N. Y. Annual meeting, June 9-11, at St. Louis.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION. Sec.: Walter Mower, Detroit. Annual meeting, Oct. 10-15, at St. Louis.

AMERICAN SOCIETY FOR TESTING MATERIALS. Sec.: Prof. Edgar Marburg, University of Pennsylvania. Annual meeting, June 16-18, at Atlantic City, N. J.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Joint meeting with the Institution of Mechanical Engineers of Great Britain, May 31 to June 3, at Chicago.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Oct. 10-15, at St. Louis.

AMERICAN WATER-WORKS ASSOCIATION. Sec.: J. M. Diven, Elmira, N. Y. Annual convention, June 6 to 10, at St. Louis.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple, Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

CANADIAN ELECTRICAL ASSOCIATION. Sec.: C. H. Mortimer, Toronto, Ont. Annual convention, June 15-17, at Hamilton, Ont.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays, from October to May.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry block. Convention at St. Louis.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, Sept. 13-14, at St. Louis.

INTERNATIONAL ELECTRICAL CONGRESS. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12 to 17, at St. Louis.

INTERNATIONAL ENGINEERING CONGRESS. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting, Oct. 3 to 8, at St. Louis.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs, N. Y.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Sec.: W. H. Morton, Utica, N. Y. Annual convention, Sept. 14-16, at St. Louis.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Meeting, Sept., at St. Louis.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Sept., at St. Louis.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

RAILWAY WATER SUPPLY ASSOCIATION. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter at Alexander Hall, South Minneapolis, Minn.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION. Sec.: J. C. Rockhold, Stockton, Cal. Annual meeting, Sept., at St. Louis.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, Sept. 1-3, at St. Louis.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, except June, July, August and September, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 13th, at Chicago.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. John Bogart, consulting engineer, has moved his offices from 40 Wall Street to 16 and 18 Exchange Place, New York.

—Mr. H. V. Croll, who has been in charge of the Salt Lake City office of the Allis-Chalmers Company for several years, and who was before that the representative of the E. P. Allis Company at Spokane, has been given charge of the Allis-Chalmers office at San Francisco in the Hayward building as the successor of Mr. George Ames, who has resigned.

—Mr. R. V. Norris has resigned as chief engineer of Coal and Water Companies of the Pennsylvania Railroad Company, with which he has been connected for the past eighteen years, and by which companies he has been retained as consulting engineer, and has opened offices at 99 John Street, New York, and in Wilkes-Barre, Pa. He will give particular attention to the examination of coal properties; the construction, mechanical equipment and modernization of mines and power plants; the design of handling and storage plants for coal and ores; the design of coal breakers and mining machinery and of waterworks and power plants.

—Mr. Irving A. Taylor, who has for many years been connected with the electrical industry, both on the manufacturing side and as consulting engineer, associated with A. B. Herrick, has joined the staff of the Engineering Company of America.

—Messrs. Charles Henry Davis and partners, of 25 Broad Street, New York, have dissolved their firm. Messrs. Davis and Nat Tyler, Jr., have formed a co-partnership under the name of Charles Henry Davis & Company, with the same address. Mr. John S. Griggs, Jr., will continue the practice of consulting engineering, also at the above address, and Mr. Timothy W. Sprague has his consulting engineering office at 4 State Street, Boston.

—Mr. James L. Teller, for thirty-four years prominently identified with the Fishkill Landing Machine Co., Fishkill-on-the-Hudson, N. Y., as secretary and treasurer, died recently at his home in Newburgh.

—Mr. James D. Smith, the secretary and treasurer of the J. D. Smith Foundry Supply Co., of Cleveland, died recently.

—Mr. John Reilly, president of the United States Metallic Packing Company and of the Millwood Coal & Coke Company, and vice-president and treasurer of the American Locomotive Sander Company, died recently at his home in Philadelphia.

Industrial Notes.

—THE ENGINEERING MAGAZINE has moved its offices to the Nassau-Beekman Building, 140-142 Nassau Street, corner of Beekman Street, New York, where it will occupy suite 1411 to 1417. Its new telephone number is 5520 John.

—The three engineering societies who are to occupy the Union Engineering building have appointed members to serve on a Joint Library Committee, which has taken up the work of unifying and harmonizing the methods of their several libraries, in order that they may be so administered as to best promote their usefulness to all the societies and to the engineering profession at large. The following gentlemen constitute this committee: For the American Society of Mechanical Engineers: Ambrose Swasey, Henry R. Towne and H. H. Suplee; for the American Institute of Mining Engineers: John Hays Hammond, Leonard Waldo and James Douglas; for the American Institute of Electrical Engineers: W. D. Weaver, M. I. Pupin and F. W. Jones. The committee has organized and has chosen Mr. Hammond for president and Mr. Suplee, of 140 Nassau Street, New York, for secretary. Regular meetings will be held on the first Tuesday of each month, except July and August.

—The American Society of Mechanical Engineers and the Institution of Mechanical Engineers (of Great Britain) will hold

a joint meeting at Chicago from May 31st to June 3d. The professional sessions will begin on the morning of June 1st, when papers on the wages problem and on refuse destructors will be read and discussed. The evening of June 1st will be devoted chiefly to papers on steam turbines, the morning of June 2d to papers on power plants, superheated steam and gas-engine testing, and the morning of June 3d to papers on cast iron, strain and annealing, a lathe-tool dynamometer and locomotive testing. There will be a number of excursions to various places of interest, and the local committee has arranged a very complete social program for the entertainment of the visiting engineers and the ladies accompanying them.

—The Canadian business of the Allis-Chalmers Company, which recently acquired the Bullock Electric Manufacturing Company, of Cincinnati, will hereafter be conducted by a new organization bearing the name Allis-Chalmers-Bullock, Ltd. The works and principal offices of this important new Canadian company are in Montreal.

—Crocker-Wheeler Company, the manufacturers of electric generators and motors, will on May 10th open a branch office in the Hibernia Bank Building in New Orleans. Mr. W. P. Field, of the St. Louis office of the company, will be the representative in charge. Although there are fifteen Crocker-Wheeler branches from Boston to San Francisco, including St. Louis and Atlanta, this new office has been made necessary to accommodate the steadily increasing market for electric machinery in the South and Southwest.

—The Reeves Engine Company have just closed a contract with the Drew-Selby Company of Portsmouth, Ohio, for one of their 400 horse-power vertical cross-compound engines for direct connection to electric generator. Messrs. Plotner & Stoddard, of Dayton, Ohio, have also purchased a direct-connected 400-horse-power vertical cross-compound. The Reeves Company have sold to the International Steam Pump Company four direct-connected vertical cross compounds. The Trenton Mills & Elevator Company have purchased one of these large engines, and the Reeves Company have contracted with the Construction Realty Company to install three simple horizontal engines for direct connection to 65-kilowatt generators, for the latter's new hotel at Broadway and Sixty-ninth Street, New York.

—The Bristol Company, of Waterbury, Conn., have an exhibit at the World's Fair in St. Louis, which is located in Electricity Building. Their booth is situated by the main entrance, in space 36, where they show a complete line of their recording instruments for pressure, temperature and electricity. These instruments will be exhibited in the various styles and sizes which are manufactured, and in different finishes. The construction and operative parts will also be shown, and a large number of the instruments will be in actual operation, enabling visitors to observe the manner of operation and the records the instruments make, besides their extreme simplicity, and the delicacy and accuracy which it is possible to obtain without sacrificing any of the necessary elements which are essential in a commercial form of recording instrument. There will also be shown a complete line of specimens of Bristol patent steel belt lacing, which comprises over 150 different sizes for all kinds of belting, from the thinnest to the heaviest that is manufactured.

—The Brown Corliss Engine Company, of Corliss, Wis., have just received an order from the Phillips Insulated Wire Co., of Pawtucket, R. I., for two tandem compound condensing Corliss engines, one 14 and 28 by 42 inches, and the other 18 and 36 by 48 inches.

—The Henry R. Worthington Hydraulic Works, at the corner of Rapelyea and Van Brunt Streets, Brooklyn, are shortly to be removed to Harrison, N. J., to occupy the new $2,000,000 plant of the International Steam Pump Co., now nearly completed. The Brooklyn site consists of two city blocks, or about four and one-half acres, while the Harrison plant is located on a 35-acre tract, and contains 18 acres of floor space. The Worthington Company is one of the oldest and largest manufacturing concerns in Brooklyn, having been founded in 1843 by Henry R. Worthington, the inventor of the duplex steam pump and other hydraulic devices. About 2,000 men are employed in the South Brooklyn works, and many will undoubtedly go to the new plant at Harrison, which will accommodate from

5,000 to 6,000 men. The Brooklyn works will probably be sold, the company having already disposed of its large foundries at Elizabethport, N. J.

—The Watson-Stillman Company have moved their offices and a large stock of goods to 46 Dey Street, New York, and all of their machinery to their new works at Aldene, Union County, N. J. (four miles west of Elizabeth, and one-half mile from Roselle depot via trolley), where they will have ample room to expand and conveniently handle such work as may be given them.

—The Register of Lehigh University, South Bethlehem, Pa., just issued, copies of which may be had on application, shows the attendance of 615 students from 24 States and 10 foreign countries. There are 54 in the teaching staff. Thirteen four-year courses of instruction are offered at the University: the Classical Course, the Latin-Scientific Course, the courses in Civil, Mechanical, Marine, Metallurgical, Mining, Electrical and Chemical Engineering, Analytical Chemistry, Geology, Physics and Electrometallurgy. A list of graduates of the University, 1304 in number during the 38 years of its existence, indicates that this institution is exerting a very marked influence on the industrial development of the United States, and also of foreign countries. Provision is made for worthy and needy students whereby they may postpone payment of tuition until after graduation.

—The Lunkenheimer Company are issuing a handsome metal hanger, to be displayed by dealers who sell their steam specialties.

—The Boston & Maine Railroad issues, through its passenger department, an attractive set of summer publications descriptive of New England scenery and summer resorts, and has also published a convenient booklet containing a condensed summary of the fish and game laws of Maine, New Hampshire, Massachusetts, Vermont, Quebec, Nova Scotia, New Brunswick and Newfoundland.

—The summer school of the Thomas S. Clarkson Memorial School of Technology, at Potsdam, N. Y., will open on July 6, and will continue in session until August 17. Courses of instruction are offered in history and literature, physics and electricity, chemistry, photography, mathematics, home science and manual training. Detailed information will be furnished on application to The Secretary, Clarkson Summer School, Potsdam, N. Y.

—The William Tod Company, of Youngstown, Ohio, the builders of heavy-duty Corliss engines, pumping engines, blowing engines, hoisting engines and gas engines, have established an office at 29 Broadway, New York, and have appointed as their Eastern agent Mr. Geo. F. Woolston, formerly of Woolston & Brew.

—The Broderick & Bascom Rope Company, of St. Louis, have issued an attractive blotter for desk use, ornamented with designs illustrative of their wire-rope products, which they will distribute to their customers, who visit them at the St. Louis Fair.

—The Pennsylvania State College will begin its next college year on September 15. Examinations for admission will be held at the college, in Centre County, on June 16, and on September 13 and 14. Local examinations will be also be held on June 30 and July 1 at Philadelphia, in the Central Y. M. C. A. Rooms; in the high schools of Scranton, Johnstown, Erie, Harrisburg and Reading; and at Pittsburg, in the Central Board of Education. Further information may be obtained from The Registrar, State College, Centre County, Pa.

—The Lubrication Publishing Company, of Pittsburg, is bringing out a second edition of Mr. W. M. Davis's book on "Friction and Lubrication." The author has revised this work and added considerable new matter and illustrations, which will bring its size up to 250 pages.

—Dunham steam traps, manufactured by the C. A. Dunham Company, of Marshalltown, Iowa, are used in the power plant of the St. Louis Exposition. These traps are of two styles, namely low pressure, with by-pass, and standard, operating upon a pressure of 150 pounds above atmosphere, and if desired they can be fitted with a balanced valve by eliminating the by-pass feature, so enabling them to work equally well on high- and low-pressure steam.

—The Massachusetts Institute of Technology will hold its entrance examinations at the Rogers Building, 491 Boylston Street, Boston, on June 30 and July 1 and 2.

Examinations in other cities will be held by the College Entrance Examination Board from June 20 to 25. For further information concerning the latter, address Dr. Thomas S. Fiske, Secretary, College Entrance Examination Board, P. O. Sub-Station 84, New York. The M. I. T. offers a number of summer courses during June and July, supplementing the work of the regular college year. Any further information desired will be given by H. W. Tyler, secretary, Massachusetts Institute of Technology, Boston.

—An announcement has been made by the Joint Committee on the Union Engineering Building, which is to be erected by Andrew Carnegie for the American Society of Mechanical Enginers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers, together with an adjoining building for the Engineers' Club, of New York, from which the following extracts are taken: "The preliminary work of the Conference Committee on the Union Engineering Building was closed April 15th, after a considerable amount of labor on the part of all interested, and the program of competition was placed in the hands of architects about May 1st. In this work the committee has enjoyed the advice of Prof. W. R. Ware, late of Columbia University, as professional adviser, and it is needless to say that the program has been drawn with great care. The Engineering Building on Thirty-ninth Street, about midway on the north side of the block, will occupy about 10,500 square feet, exclusive of the 15 feet open space reserved under the city ordinances, the outside dimensions of the land being about 125 feet by 100 feet. To the east of the building Mr. Carnegie has bought and reserved a residence, which will be maintained at its present elevation so as to protect the air and light of the building on that side. The general plans of the building may be briefly stated as follows: There will be at the top of the building three stories held for the use of technical societies invited to participate in the benefits of the building. Three other similar floors will be reserved, one each for the American Institute of Electrical Engineers, the American Institute of Mining Engineers and the American Society of Mechanical Engineers. These floors will make ample provision for offices, and each will have a large, handsome reception room, as well as board and committee rooms. Below these will be the library, virtually a double floor; although the committee will entertain plans placing the library at the top of the building. Next below will be a large main auditorium floor, which will seat from 1,200 to 1,500 people, with 1,000 on the floor and about half as many additional in the galleries. This floor will preferably be as near the sidewalk as possible, and may have above it or below it a number of smaller meeting rooms having similar purposes, seating audiences of from 500 down to 100. The floor on the street level will be appropriated mainly to administrative purposes, with three coat rooms capable of taking care of 1,500 garments at once, a ladies dressing-room, a bureau of information, public telephone and telegraph offices, the post office and other offices. For the purposes of the Engineering building and the Engineers' Club regarded as separate structures, it is proposed to expend about $1,000,000, leaving the other $500,000 for tearing down of old buildings, excavation, architects' and engineers' fees, machinery, elevators, lighting fixtures and the equipment of the library and auditorium." The following architectural firms have accepted the invitation of the Joint Committee to submit designs in the mixed competition: Ackerman & Partridge, Carrère & Hastings, Clinton & Russell, Lord & Hewlett, Palmer & Hornbostel, Whitfield & King. Each of these firms will receive $1,000, which is to be charged against the commission of the successful competitor. Any other architects will be permitted to compete and will be furnished with printed programs of the competition by the secretary of the committee, Prof. F. R. Hutton, of 12 West Thirty-first Street, New York. The competitors on the open list will receive prizes of $400 for each of the four best designs. The date for the filing of the competitive plans is June 20th, and as soon thereafter as possible the committee will make its decision, and will then proceed with the work without delay.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Aerial Tramway.

Pamphlet containing a well-illustrated account of the Leschen Company's patent automatic aerial wire-rope tramway built for the North American Copper Co., at Encampment, Wyo. This aerial tramway is sixteen miles long and passes over the Continental divide at an altitude of 10,690 feet, and conveys the ores from the mines of the copper company to their smelter. 6 by 9½ in.; pp. 24. A. Leschen & Sons Rope Co., St. Louis.

Boilers.

Pamphlet containing illustrations and descriptions of the Milne high-pressure water-tube boiler and steam superheater. The construction of the boiler embodies feed-water re-heating or economizer tubes, and the whole design of boiler and superheater combines simplicity and efficiency. 11 by 8½ in.; pp. 10. Milne Boiler Company, 95-97 Liberty St., New York.

Coal Storage.

Large book, in flexible-cloth binding, with full-page illustrations on tinted paper, containing descriptions of various installations of the Dodge system for the stocking or trimming out of coal to be stored, both out-of-doors and in buildings, and the reloading from storage for further transport, both operations being performed by continuous conveyors. 11½ by 9 in.; pp. 55. The Dodge Coal Storage Company, Nicetown, Philadelphia.

Compressed-Air Cleaning.

Catalogue E, describing the Thurman "dustless" method of cleaning carpets, furniture, draperies, ceilings, walls and everything else in houses and other buildings, without removing them from their places, by means of compressed air, with many illustrations of the application of the system, and also of disinfecting, painting and grease-removing apparatus, besides lists of users and testimonials, 6¾ by 5 in.; pp. 102. General Compressed Air House Cleaning Co., St. Louis.

Compressed-Air Locomotives.

"Record of Recent Construction, No. 46," containing a very well illustrated account of compressed-air locomotives for mine haulage and other service, with descriptions of compressed-air haulage plants, comparative costs and other useful information. 6 by 9 in.; pp. 40. Baldwin Locomotive Works, Philadelphia.

Compressors.

Bulletin L 511, with illustrations and descriptions of compressors intended for pressures of 30 pounds and under, built with open suction for air or with closed suction for handling carbonic acid and other gases. The inlet valves are of the semi-rotary type and the outlet valves of the poppet type, and the steam-valve gears are of the Meyer or Corliss types. 9 by 6 in.; pp. 12. Laidlaw-Dunn-Gordon Co., 114 Liberty St., New York.

Concrete-Steel.

Pamphlet, containing an historical and descriptive account of the Ransome system of concrete-steel construction, in which the concrete is reinforced by twisted bars of steel, illustrated with many half-tones of buildngs, bridges and other structures built on this system, together with results of tests and much other information. 9 by 6 in.; pp. 75. Ransome Concrete Machinery Co., 11 Broadway, New York.

Conveyors.

Catalogue No. 57A, with illustrations and descriptions of conveying machinery and many details thereof especially adapted to the saw-mill, lumber and wood-working industries. 7¾ by 5½ in.; pp. 144. The Jeffrey Manufacturing Co., Columbus, O.

Corliss Engines.

Catalogue, with half-tone illustrations on heavy paper and descriptions of "Twin City" Corliss steam engines and their parts, of the works where they are manufactured and of some of the plants where they are installed. 7 by 9 in.; pp. 69. Minneapolis Steel & Machinery Co., Minneapolis.

Drawing Materials.

Catalogue and price-list, with illustrations and descriptions of drawing instruments, paper, tracing cloth, blue-print frames, electric blue-print machines, scales, drawing tables, transits, theodolites, levels, plane tables, current meters, tide gauges, and many other kinds of drawing materials and surveying instruments. 8½ by 5¾ in.; pp. 415. Eugene Dietzgen Co., Chicago.

Dynamos.

Circular No. 41, with illustrated description of a direct-current electric generator especially designed to be driven with gas or gasoline engines by means of belting. On the dynamo shaft is a heavy flywheel, which, with the generator, is supported by three bearings mounted on an adjustable iron base. 9 by 6 in.; pp. 2. Commercial Electric Co., Indianapolis.

Electric Locomotives.

Large pamphlet, No. 1045, containing handsomely illustrated descriptions of electric locomotives for coal, copper and other mines, for both surface and underground service, of installations in operation in many parts of the world, and of various details of locomotives and plants. 10½ by 8 in.; pp. 71. General Electric Co., Schenectady, N. Y.

Fan Motors.

Catalogue No. 38, with illustrations, descriptions and prices of "The Standard" electric fan motors, in desk, bracket, ceiling and oscillating styles, the latter automatically turning from side to side and delivering a current of air all about the room. 9 by 6 in.; pp. 12. The Robbins & Myers Co., Springfield, O.

Fireproof Construction.

Catalogue describing the Clinton fireproofing system, in which electrically-welded wire cloth is used to reinforce concrete, with illustrations of its application to floors, arches, ceilings, columns, roofs and other forms of construction, reports of tests and views of buildings. 6 by 9 in.; pp. 76. Clinton Wire Cloth Co., Clinton, Mass.

Flanges.

Circular E, with description, illustrations, prices and dimension table of high-grade, forged-steel flanges suitable for riveting to pipe and sheet iron work. 11 by 8½ in.; pp. 2. American Forged Steel Flange Co., Chicago.

Forge.

Booklet, entitled "Annealing, Hardening, Tempering and Case Hardening," containing descriptions and illustrations of Braun's portable forge and temperng furnace and of the Cary hydrocarbon burner, which operates the forge, together with much useful information. 6 by 3½ in.; pp. 16. F. W. Braun Co., Los Angeles, Cal.

Gasoline Traction Engines.

"Blue Book" with illustrated descriptions of gasoline engines having an oil-cooling system, for stationary and portable service, and of gasoline traction engines for agricultural and other uses, which possess many strong points and have proved their merit in practical operation. 9 by 6 in.; pp. 31. Hart-Parr Co., Charles City, Iowa.

Gas Producers.

Catalogue No. 19, containing descriptions and illustrations of the Weber suction gas producer which uses charcoal, coke, anthracite coal and other fuels, of gas engines, and of complete gas power plants, with useful information and tables. 8 by 11 in.; pp. 12. Weber Gas & Gasoline Engine Co., Kansas City, Mo.

Hand Blowers.

Booklet, with illustrations and descriptions of geared hand blowers for furnishing blast for forges and other purposes, portable forges, and other blacksmith tools and appliances. 6¼ by 3½ in.; pp. 8. Buffalo Forge Co., Buffalo.

Machine Tools.

Catalogue T, containing illustrations and descriptions of punches, shears, beveling and clipping machines, rail-straightening press, plate-bending rolls, plate-straightening machines, plate-planing machines, and other machine tools for working plates, bars and structural shapes. 9 by 9 in.; pp. 28. Hilles & Jones Company, Wilmington, Del.

Metal Structures.

Catalogue containing descriptions and half-tone illustrations of elevated water tanks, water towers, stand pipes, railway water tanks, smoke stacks, large riveted pipe, bridges and other metal structures, with tables of fire-stream data for various sized nozzles. 6¾ by 5 in.; pp. 62. Chicago Bridge & Iron Co., Washington Heights, Chicago.

Pumping Machinery.

Catalogue K-104, containing illustrations and descriptions of pumping machinery for beet sugar factories, including feed pumps, tank pumps, vacuum pumps, power pumps, air compressors and other apparatus. 7¼ by 5¼ in.; pp. 65. Knowles Steam Pump Works, New York.

Rheostats.

Several catalogues, bound together, with illustrations and descriptions of electric-motor starters, automatic motor speed controllers, dynamo field rheostats, sparkless controllers for printing-press motors, resistance units, theatre dimmers, and other kinds of electric resistances, switches and circuit breakers. 10½ by 8 in. Ward Leonard Electric Co., Bronxville, N. Y.

Steam Engines.

Catalogue, with half-tone illustrations on tinted paper and descriptions of blowing engines, reversing engines, Corliss engines and automatic engines for rolling mill and electric power service. 7 by 10¼ in.; pp. 20. Wm. Tod Co., Youngstown, O.

Steam Turbines.

Catalogue, containing half-tone illustrations and descriptions of Westinghouse-Parsons steam turbines and various plants where they are installed, with comparisons between the steam turbine and the reciprocating engine, and an exposition of the many advantages of the former. 9 by 6 in.; pp. 46. The Westinghouse Machine Co., East Pittsburg.

Storage Batteries.

Bulletin No. 80, containing an illustrated article by John Murphy, reprinted from *The Electrical World and Engineer*, on the installation of "chloride" accumulators at the hydro-electric power plant of the Ottawa (Canada) Electric Railway Company. 10½ by 8 in.; pp. 8. The Electric Storage Battery Co., Philadelphia.

Street Railway Signals.

Bulletin No. 1, with illustrated description of a standard automatic non-interfering, two-line-wire, block signal system, which is applicable to all electric railway systems and is especially adapted for single-track trolley roads. 10½ by 8 in.; pp. 12. Uni Signal Company, Cambridge, Mass.

Valves.

Illustrated catalogue and price-list, containing descriptions of gate valves in iron and bronze, "lenticular" valves, hose valves and Siamese connections, indicator devices for automatic sprinkler systems, hydrant mains, fire pumps, etc., indicator post valves, globe, angle, radiator and corner valves, hydrants, and other styles of valves for water, steam, ammonia, garbage, gas and other substances. 5 by 9 in.; pp. 128. The Kennedy Valve Manufacturing Co., 57 Beekman St., New York.

Zinc.

Pamphlet, entitled "Two Stories of Zinc," containing a reprint from *The Lead and Zinc News* which gives well illustrated and interesting accounts of the extraction of "spelter" or metallic zinc, from its ores, and of the manufacture of sheet zinc; and also a map showing the zinc mining districts and zinc smelters in the United States. 9 by 5 in.; pp. 24. Lanyon Zinc Company (F. E. Drake, President), St. Louis.

IMPROVED MACHINERY

New Processes and Appliances

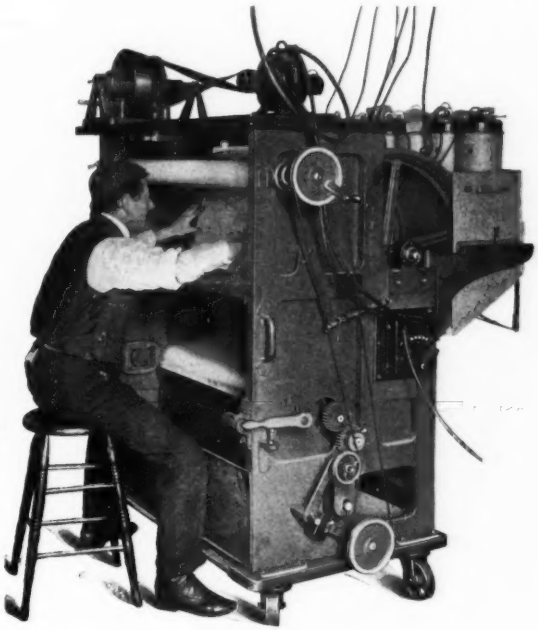
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Federal Blue-Printing Machine.

THERE are so many inconveniences in making blue prints in the old way with flat frames and sunlight exposure, that blue-printing machines, employing improved methods, are rapidly coming into use, and among the best of the new apparatus of this kind is the Federal machine.

The principal on which this apparatus works is shown clearly in the cross section on the next page. Its principal parts consist: first, of a drum revolving freely in roller-bearings; second, a feed or let-off roll above said drum, and carrying a long, transparent, flexible apron; third, a pair of pulling-rolls under the drum and connected to the source of power through a patent speed-controlling mechanism.

The transparent apron is drawn from the feed-roll against a tension device, around the surface of the drum, surrounding the latter about half of its circumference. The transparent apron, which is in contact with the face of the drum, constitutes the exposing-surface for printing.



FEEDING THE FEDERAL BLUE-PRINTING MACHINE.

The tracings and blue-print paper are fed between the apron and surface of drum at the top of the machine, and being carried around as the drum revolves, are exposed to the action of either sun or electric light,

and afterward drop out automatically into a box provided for the purpose.

The transparent apron consists simply of a roll of tracing-cloth, wound upon the let-off roll, and passing around the periphery of the drum to two pulling rolls, and then to a take-up roll which winds it up automatically as fast as used. After its entire length has been drawn around through the machine, it is re-wound in two three minutes, ready for another run of exposures.

Tracing cloth, when in close contact with the work, will transmit rays of light in practically the same time as plate glass. With ordinary care it will last indefinitely. It has the advantage also of being renewable at any time with little trouble, and at a small fraction of the cost of plate glass.

The size of blue prints that can be taken on this machine is limited only by the width of the drum and the length of the apron. The ordinary roll of tracing cloth is 24 yards long, which will be found sufficient for almost any drawing made, but double-length rolls, 30 and 42 inches wide, can be furnished, if desired.

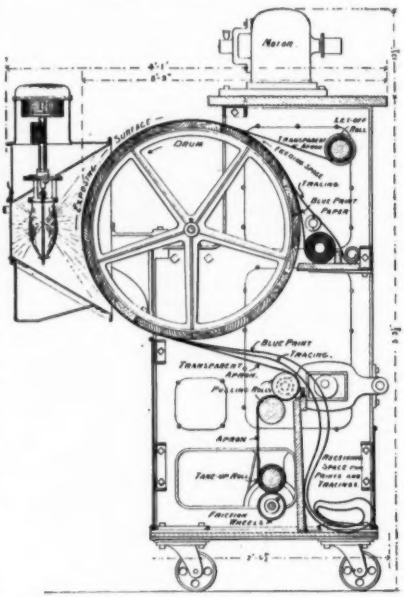
Exposures may be made by this machine either on a continuous roll of blue-print paper or on separate sheets. If a continuous roll is used, the end of the paper is started under the transparent apron on the upper surface of the drum, and the tracings placed one after another upon it as the drum revolves. The chemical side of the paper is toward the operator; the tracing is placed right side up, on its surface; he can see just where to place his tracing with relation to the blue-print paper, and there is no possibility of any slipping after it has commenced its exposure.

The speed of printing depends on three factors, the same as with the old method; viz., sensitiveness of blue-print paper, transparency of drawings, and amount of light available. In solar printing, under a bright sun at noon, the speed of this machine, using rapid printing-paper and ordinary tracings, is as high as that with which the operator can properly feed the tracings. It is found that four to six running feet per minute will require prompt work on the part of the operator to keep the machine "well fed."

The speed of the machine is under perfect control, however, and by simply moving a handle either to the right or to the left all the variations that may be required for fast or slow printing are instantly made while the machine is running.

In cloudy weather it is advisable to do all printing by electric light, as it saves an enormous amount of time and gives much more satisfactory results than dim daylight. With electric light, the amount of illumination remains practically constant, so that exposures may be accurately timed.

The change is quickly made from electric



CROSS SECTION OF FEDERAL BLUE-PRINTING MACHINE.

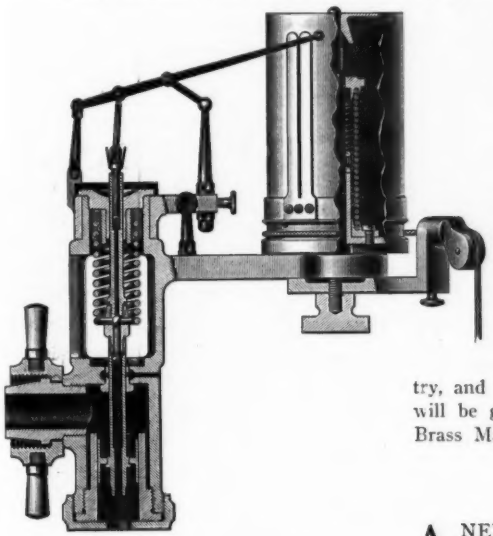
to sunlight printing by slipping out the reflector which holds the lamps and removing two brackets from the machine. It is ready then for exposures to sunlight by rolling the machine out where the direct rays can fall on the exposing-surface of the drum. When it is desired to use the machine for electric printing again the brackets are put in place and the reflector slipped into position, and the change requires but a few moments.

Any further information that may be desired will be gladly furnished by the makers, the Spalding Print Paper Co., Inc., of Boston.

Star Outside-Spring Indicator.

UPON the reliability of its spring depends the value of the steam-engine indicator as a means for measuring the power developed by an engine, and a spring which is subjected to compression and exposed to the action of high-pressure steam is not unlikely to have its accuracy seriously impaired.

A consideration of the short-comings of the ordinary indicator has led to the designing of the instrument illustrated herewith. As can be seen, the spring is exposed to view and open to the air, so that it will not become unduly heated and it is elongated or pulled apart, instead of being compressed or even pushed apart. The piston of the indicator is at the end of the rod connecting it with the spring, so that the pull on the latter is in a perfectly straight line and there is a minimizing of friction.



STAR OUTSIDE-SPRING INDICATOR.

The connection to the cylinder of the indicator is at the side instead of at the bottom as in other types, this style of connection causing steam to be taken on top of the piston. The cylinder can be readily removed for examination or replacement without in any way interfering with the other parts of the indicator. The end of the cylinder has no connection with the outer wall of the indicator, which allows the cylinder to be surrounded by live steam, which practically forms a steam jacket. By unscrewing the cap from the lower end of the cylinder, the piston can be removed with a socket wrench, for cleaning or oiling, without in any way disturbing other parts of the indicator.

The operation of the pencil movement is directly opposite to that of the inside spring types, the atmospheric line being at the top of the drum instead of at the bottom.

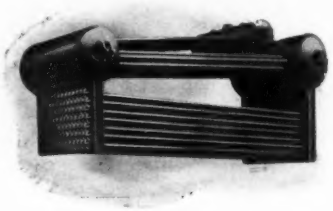
The area of the piston has been reduced from one-half a square inch to a quarter of a square inch, so allowing the use of a much smaller size of wire for the spring, which secures greater elasticity and freedom of operation, and keeps down the weight of the moving parts.

The advantages of this type of indicator are so great that it has been adopted for use in many of the largest power plants and technical schools throughout the country, and further information concerning it will be gladly given by the makers, Star Brass Manufacturing Co., of Boston.

Atlas Boilers.

A NEW water-tube boiler has been placed on the market by the Atlas Engine Works, in which the builders believe they have eliminated practically all the difficulties heretofore experienced with this type of boiler. The boiler purifies its own feed water, superheats its steam and provides for a practically unimpeded circulation. It is a horizontal boiler, composed of two water legs, three drums running across the setting and connecting tubes. The rear and front drums are made of continuations of the same plates that form the rear and front water legs, a method of construction that prevents any seam of any kind from being exposed to the flame or hot gases. The legs open into these drums the full length of both legs and drums, thus avoiding the contraction at the throat which impedes circulation in so many of the water-tube boilers. In the rear drum is located a live-steam purifier, independent of

the drum, and so arranged that it can be blown out at any time without interfering with the operation of the boiler. The generating tubes between the water legs are set on a slight incline and each is commanded by a separate handhole at each end. Equalizing tubes between the front and



ATLAS WATER-TUBE BOILER.

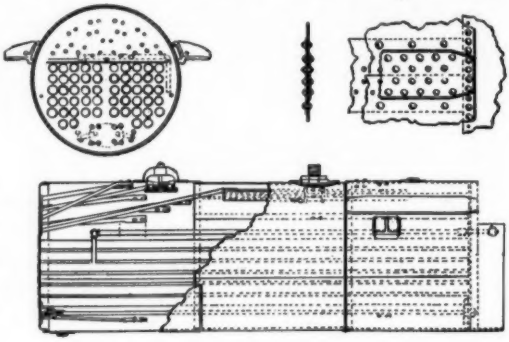
rear drums help to perfect the circulation and keep an equal water level in both these drums. Superheating tubes entering these drums above the water line carry the steam to the middle or steam drum, whence it is piped for use. The boiler is built in sizes ranging from 100 horse power up, and can be erected and shipped as a whole, or in sections, in which latter case, all the riveting is done at the shops and the tubes are expanded into the legs and drums after arrival.

The points of advantage claimed for the design are numerous. Not only dry, but superheated steam is assured, making it impossible to throw water into a cylinder or give wet steam. The purification of the water gives long life to the boiler and necessitates less fuel and labor. The facilities for cleaning are unsurpassed. Ample manholes give access to the drums, and all the tubes carrying water are straight and readily accessible. The superheating tubes, carrying steam only, are slightly curved to take care of the expansion. By geting all seams away from the fire and hot gases, the possibility of leaks at the rivets, or of plates cracking from the rivet holes to the edge is eliminated. The masonry required is simple and comparatively inexpensive, consisting of straight side walls and bridge walls, with no overhanging walls between or to the drums. Materials and workmanship throughout are the best.

The Atlas Engine Works has also added to its standard line of tubular boilers a new boiler of triple-riveted butt-strap construction for a constant working pressure of 125 pounds, to supply the demand for a boiler of intermediate pressure. It is built in seven convenient sizes, ranging from 48 inches by 14 feet, rated at 50 horse power, to 72 inches by 18 feet, rated at 150 horse power. The size, number and arrangement of the tubes is such as to insure good draft and excellent circulation. Details of riveting and bracing are fully shown by the line drawing. The boiler throughout is of high-grade materials and workmanship, and further details will be gladly furnished by the Atlas Engine Works, of Indianapolis.

Traverse Shaper with Pull-Cut Head.

THE difference between this and the ordinary type of traverse shaper is that the cutting tools are reversed, the cutting taking place during the backward motion of the ram and quick return during the forward, the operation being directly opposite to that in the usual form.

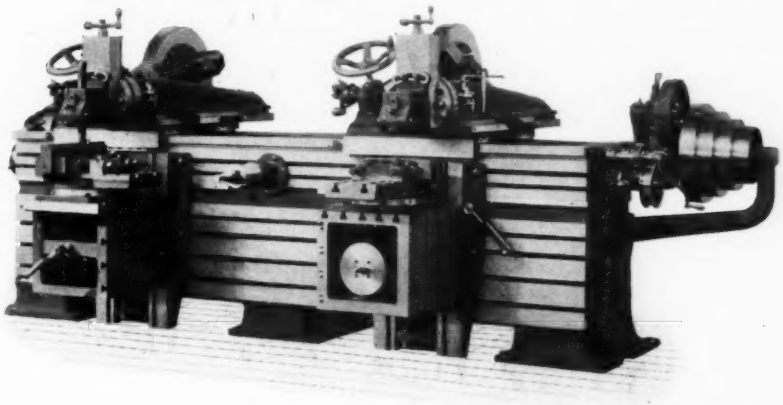


ATLAS TUBULAR BOILER.

The advantage of this type is that the pressure or thrust of the tool is taken directly back against the bed of the machine, and tends to draw the table and apron more closely to the bed, rather than force them apart. This is of a decided advantage, es-

pecially when heavy cutting is being done, as is the case since the introduction of high-speed steels. Then, in many cases, the work itself can be pressed directly against the bed of the machine, so that the resistance to the cutting is not altogether dependent upon the hard clamping of the work and the table. Large pieces can also be directly bolted to the bed, the tables being removed.

The head is so constructed that the stress due to the cut comes directly upon solid metal contacts, and not upon threads, bolts or screw points, except in the case of the set screws for holding the tool. These screws are large in diameter, and have a long bearing. The whole construction of the head is one of great rigidity and strength, having the least possible tendency to yield or spring under the cutting strain. Except for the head, ram and such other modifications as have been deemed necessary, this traverse shaper is similar to the ordinary push-cut machine heretofore and still made by the Cincinnati Shaper Company, Cincinnati, Ohio, the introducers of this tool, who will be pleased to furnish any further information that may be desired.



CINCINNATI TRAVERSE SHAPER.

The Sturtevant Improved Hand Blowers.

IN these modern times men are always seeking devices by which they may accomplish the greatest results with the least exertion. To this fact, doubtless more than any other, was due the rapid introduction of the hand blower as a substitute for the old time bellows. During the years which have elapsed since this change, the B. F. Sturtevant Co., pioneers in the manufacture of blowers, have been perfecting their design and construction until their hand blower known as Style A has shaped itself into a new design known as Style B, as herewith illustrated.

These hand blowers have been extensively introduced in connection with new forges of all kinds, and have likewise been applied to old style brick and iron forges as simple, efficient and economical substitutes for the bellows. Not only are they adapted to forge blowing, but they can also readily be applied as portable ventilating apparatus.

They are simple in design, strong, rigid and compact, easy and economical in operation and readily portable. The running gear is simple, effective and strong.

The blower is adjustable on the shaft and its outlet may thus be set to discharge in any direction and readily connected to the forge tuyere by means of galvanized iron piping. The blower is of cast iron strongly constructed in every particular, has a steel shaft running in babbitted boxes and a fan wheel of galvanized steel solidly riveted to a composition hub with extending arms.

The frame is carefully designed and well

braced and is so arranged that the slackness of the belt driving the blower may be taken up by lowering the blower shaft which is supported by collars sliding on the frame. The feet are provided with holes so that the hand blower may be readily screwed to the floor.

These hand blowers are made in two sizes. The total length on the floor of Style B-1 is 18 inches, while the total

STURTEVANT HAND BLOWER.

height of the frame, not including the handle, is 48 inches. The driving wheel is 24 inches in diameter, the blower outlet is 3½ inches in diameter and the complete outfit weighs but 135 pounds.

Style B-2 is of slightly larger dimensions and has proportionately greater capacity for delivering air. The blower outlet is 4¾ inches in diameter and the weight is 155 pounds. Further information will be cheerfully supplied by the B. F Sturtevant Co., of Boston.

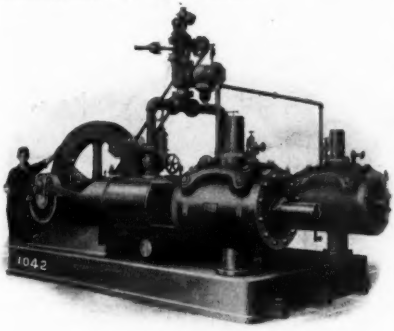
Air Compressors on Hudson River Tunnel Work.

WHILE several other tunnels are in the course of construction under the Hudson and East Rivers to connect Manhattan Island with its neighboring communities, the completion of the original so-called "Hudson River" tunnel, under the charge of Chief Engineer C. M. Jacobs, has attracted unusual attention. From the start compressed air was used, not only to operate the rock drills, but to hold back the sand and mud and overcome the obstacles which make subaqueous tunneling so hazardous. The developments of the shield system of tunneling, in which compressed air is absolutely essential, came as the tunnel advanced, and the methods which proved successful in this instance have since been adopted for other undertakings of a similar nature and are now meeting all the requirements of the work.

It is an interesting fact that from the time the Hudson River tunnel was started thirty years since, up to the completion of the first bore a few weeks ago, Ingersoll-Sergeant machinery has been used. The building of this tunnel marks the period of development in the air compressor, and at this time when the work is nearing completion, there may be seen in operation both the old and the new types of air compressors. The compressors used at the start of the undertaking were of the old water-injection type. As the work progressed these were replaced by the newer machines, with poppet inlet valves and water-jacketed cylinders. When the Hudson Improvement Company began operations two years ago, a complete equipment of modern Ingersoll-Sergeant compressors was installed, and has since supplied all the air necessary in the headings on both sides of the river.

There are two power houses, one in Jersey City and the other in New York. The Jersey City power house contains four compressors, one of the Class "H" duplex type, with steam cylinders 16 inches in diameter and duplex air cylinders 20½ inches in diameter by 16 inches stroke, and three of the Class "A" straight-line type, with 22 inches steam cylinders and 24 inches stroke. Of the latter, two have air cylinders 26¼ inches in diameter and the third has an air cylinder 22¼ inches in diameter.

The equipment of the New York power house, at the foot of Morton Street, includes two duplex Class "H" compressors similar in size to the one at the Jersey end of the tunnel, and one straight-line Class "A" machine with steam cylinders 22 inches in diameter, air cylinders 22¼ inches in diameter, and 24 inches stroke.



INGERSOLL-SERGEANT DUPLEX AIR COMPRESSOR.

Now that the first bore is completed, these machines are being used in building the second one, which is to be parallel to the other.

Further information concerning this compressed-air machinery will be gladly supplied by the Ingersoll-Sergeant Drill Co., of 26 Cortlandt St., New York.

Portable Forge and Furnace.

ON account of its many good points, the Braun portable forge and tempering furnace, which is shown in the accompanying illustration, will be of great interest to metal workers generally. This apparatus is portable in the widest sense. It can be easily moved from one place to another about the workshop without disturbing it.

When desired, the fuel tank and burner can be detached and taken to any convenient spot for use. When shipped it is knocked down and can be packed in a number of parcels, which makes it easy to transport to any point.

The fuel used in Braun's Portable Forge is gasoline, which is burned in a Cary hydrocarbon burner. This gives a flame of unusual intensity which, with the peculiar construction of the furnace and forge, adapts it to a wide range of uses. The operation of the furnace is extremely economical, the gasoline being burned under air pressure in a manner that produces almost perfect combustion, only three quarts of gasoline per hour being required to keep the burner running at its normal capacity.

Heating, hardening and tempering are accomplished with unusual and uniform success, and the detached burner is most satisfactory for brazing and other forms of special shop work.

The Braun portable forge and furnace takes up very little room and can be put into any shop, no matter how cramped the quarters. It occupies a floor space 23 by 23 inches and stands 48 inches high.

It is so constructed that the gasoline tank, which is 9 inches in diameter and 17 inches high, rests on a shelf between the legs of the furnace, and is therefore included within the above measurements.

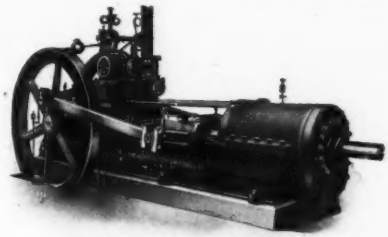
The size of the furnace proper is 16 by 19 inches and it is 18 inches high.

The fire-clay portion of the forge and furnace contains two different compartments:

Below there is the forge. The flames are forced directly into the forge and it is used for heating metals in direct contact with the flame.

Above is the muffle. The flame does not enter the muffle, which is heated through its fire-clay walls. This is used for annealing and similar operations.

The inside of the muffle is 4 inches high,



INGERSOLL-SERGEANT STRAIGHT-LINE AIR COMPRESSOR.

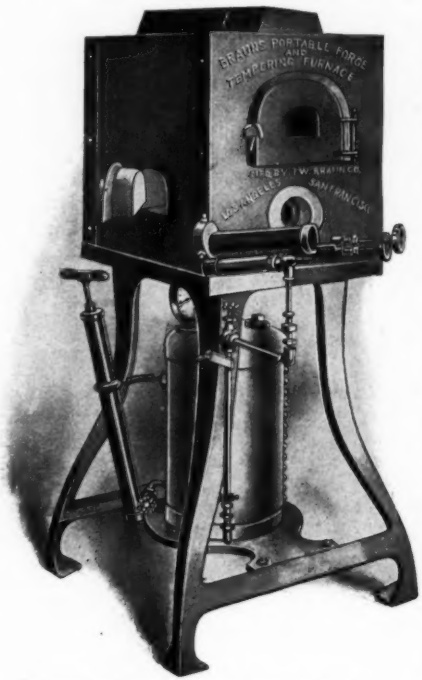
6 inches wide and 11½ inches long, and it has an arched roof. The dimensions of the forge are the same.

In the forge there is a front opening where the flame enters, and openings on each side 3½ by 5 inches, which are closed

by fire-clay plugs except when long work is being heated. These long pieces can be passed directly through the two side openings.

The muffle has a door in front 4 by 6 inches, with an isinglass center. There is also an opening in the back which is ordinarily closed by a slide. The slide may be removed to give a draft directly through the muffle when it is desired to cool it quickly.

The flames from the Cary burner enter the forge under pressure, pass down through the length of it, and strike the rear wall, which is built in such a way as to turn the current of flame back along the ceiling of the forge, where it passes up through openings at the sides of the muffle until it reaches the ceiling over the muffle. Here it is deflected downward onto the top of the muffle. By this method of construction it will be seen that metal placed in the direct path of the flame will be heated alike in all parts on account of the impact of the direct flame and the reflected flame. It also follows that the muffle will be heated equally at every point.



BRAUN PORTABLE FORGE AND FURNACE.

There is only one tank used in connection with this portable forge and tempering furnace, for the fuel tank is also a chamber for the air, and the pump is permanently attached to the tank, so that there are only two pieces of apparatus to think about, the combination air-and-fuel tank and the forge-furnace.

In the Cary burner the fuel and the air are mixed and commingled in an entirely original manner. There is no obstructing surface as in other types of burners upon which the gas and air are impinged to break them up. This breaking up is accomplished by the sudden expansion which follows contraction under pressure, in addition to the concussion of hydrocarbon gas upon the air.

The mixing tube of the Cary burner is of such shape and size that the air is drawn into it by the jet of gas under pressure and in exactly the right proportions to insure complete combustion.

Among the advantages of using this burner in connection with metal work may be mentioned:

The complete absence of oxidation.

Uniform distribution of heat in the muffle, and even heating of all sides of the metal placed in the forge.

Perfect regulation of temperature.

Over-heating entirely prevented.

No danger of cracking the work.

Uniform conditions which can be repeated at will.

Economy, because the fire burns only when actual work is being accomplished.

Availability, because the heat can be ready in three minutes, extinguished instantly, and moved about at will.

For an occasional job away from the shop, this portable burner and tank solves what has been a difficult problem.

Further particulars regarding the whole apparatus and the many uses to which it can be put will be gladly furnished by the F. W. Braun Co., Los Angeles, Cal.

NEWS SUPPLEMENT

The Engineering Magazine—July, 1904

Coming Society Meetings.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Next meeting, Oct. 4-6, at St. Louis.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Convention, Sept. 12-17, St. Louis.

AMERICAN INSTITUTE OF MINING ENGINEERS. Sec.: R. W. Raymond, 99 John St., New York. Next meeting in the Lake Superior iron and copper region, beginning Sept. 14, at Duluth.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Tuesdays of each month, from October to May, inclusive.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, Oct. 26, at Philadelphia.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION. Sec.: Walter Mower, Detroit. Annual meeting, Oct. 10-15, at St. Louis.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting. Oct. 10-15, at St. Louis.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec. S. F. Patterson, Concord, N. H. Annual convention, Oct., at Chicago.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays, from October to May.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block. Convention at St. Louis.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September, and on first and third Saturdays from October to March, inclusive.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, Sept. 13-14, at St. Louis.

INTERNATIONAL ELECTRICAL CONGRESS. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12 to 17, at St. Louis.

INTERNATIONAL ENGINEERING CONGRESS. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting, Oct. 3 to 8, at St. Louis.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

IRON AND STEEL INSTITUTE. Sec.: B. H. Brough, 28 Victoria St., London, S. W. Annual meeting, Oct. 24-26, at New York.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Sec.: W. H. Morton, Utica, N. Y. Annual convention, Sept. 14-16, at St. Louis.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Meeting, Sept., at St. Louis.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Sept., at St. Louis.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: GEO. P. LOW, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle. Annual convention, July 1-5.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesdays of January, March, May, Sept. and Nov. Next meeting, Sept. 13, at Chicago. Annual meeting, Oct. 11, at St. Louis.

RAILWAY WATER SUPPLY ASSOCIATION. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter at Alexander Hall, South Minneapolis, Minn.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION. Sec.: J. C. Rockhold, Stockton, Cal. Annual meeting, Sept., at St. Louis.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, except June, July and August, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, Sept. 1-3, at St. Louis.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 13, at Chicago.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Allen Hazen begs to announce that he has formed a partnership with Mr. Geo. C. Whipple, formerly director of the Mount Prospect laboratory of the Department of Water Supply, Gas and Electricity, of the City of New York. A department of testing and operating filters will be established and will be in charge of Mr. Whipple. Investigations as to the quality of water supplies and the means for their improvement will be undertaken. The offices of Messrs. Hazen and Whipple are at 220 Broadway, New York.

—Mr. Morris R. Sherrerd, engineer and superintendent of the Water Department of Newark, N. J., was elected president of the American Water Works Association at the St. Louis Convention, held in June.

—Dr. Hermann von Schrenk, the well-known expert in economic forestry, who is in charge of the division of Forest Products in the United States Bureau of Forestry, is the author of a report on "Cross-Tie Forms and Rail Fastenings, with Special Reference to Treated Timbers," which has been issued as Bulletin No. 50 of the Bureau of Forestry.

—Mr. J. C. McQuiston, until recently secretary, has been appointed superintendent of the The Westinghouse Companies' Publishing Department, having charge of matters relating to the publicity of the products of the various Westinghouse interests in the United States and Canada.

—Signor Enrico Bignami, the well-known Italian engineer and writer, has been invited to present a paper before the International Electrical Congress at St. Louis in September, on the electrical installations of Switzerland.

—Mr. A. M. Mattice, chief engineer of the Allis-Chalmers Co., has returned from his European tour of inspection, and has now settled down to the duties of his position in Milwaukee.

—Mr. B. Franklin Hart, Jr., begs to announce that he has severed his connection with Mr. Edwin Burhorn, and has established himself under the firm name of B. Franklin Hart, Jr., & Co., with offices at 143 Liberty Street, New York. B. Franklin Hart, Jr.. & Co. are manufacturers of boilers, stacks, tanks, and all manner of plate steel construction. They have fully equipped pattern, foundry and machine shops, in connection with the boiler shop, and are prepared to make castings of all descriptions, finished or unfinished.

—Mr. John B. Allan, formerly vice-president and general manager of the Allis-Chalmers Company, will shortly commence his duties as western manager of The Westinghouse Machine Company, with headquarters at 171 LaSalle Street, Chicago, having direct charge of the entire western district. Mr. Allan has been prominently associated with the Allis-Chalmers Company for the past twenty-four years, and has filled postions of progressively increasing importance, including those of sales manager, general manager, and vice-president.

—Mr. F. P. Thorp, who has been representing the Power and Mining Machinery Company, of New York, at Boston, is now in charge of the Pittsburg office of that company in the Farmers' Bank Building.

Mr. Paul M. Mowrey, who for the last three years has been connected with the Merchants' Trust Company as adviser on industrial investments, has assumed the office of vice-president of the Engineering Company of America, 74 Broadway, New York.

—Mr. Robert McF. Doble, of San Francisco, consulting and supervising engineer, making a specialty of hydro-electric power developments and long-distance power transmission, has become identified with the Abner Doble Company, engineers and manufacturers of tangential water wheels with needle regulating nozzles.

—Mr. H. F. Frevert, who for the past several years has been manager of the New York stores of the Niles-Bement-Pond Co. and the Pratt & Whitney Co., has severed his connection with these companies and has opened an office at 114-118 Liberty Street, for the sale of machinery. He is also manager of the New York office of the Norton Grinding Co., of Worcester, Mass., manufacturers of emery grinding machinery, and of the Brightman Mfg. Co., of Shelby, Ohio, manufacturers of turned shafting and of machines for turning, rolling, straightening and polishing shafting.

—Mr. C. C. Tyler has resigned his position as superintendent of the works of the Westinghouse Electric & Manufacturing

Co., at East Pittsburg, Pa., and has been appointed general superintendent of all the works of the Allis-Chalmers-Bullock interests in the United States. Mr. Tyler, who entered upon his new duties on June 15th, will make his headquarters at Milwaukee.

—Mr. David R. Fraser, one of the founders of what is now the Allis-Chalmers Company, died recently at his residence in Chicago.

—Mr. James A. Myers, president and treasurer of The Robbins & Myers Co., of Springfield, Ohio, died at his home in that city recently.

Mr. Clarke Merchant, the president and founder of Merchant & Co., Inc., of Philadelphia, and formerly lieutenant-commander in the U. S. Navy, died recently.

Industrial Notes.

—The main building of the Rensselaer Polytechnic Institute, at Troy, N. Y., which was used principally for recitation purposes, was practically destroyed by fire in the early morning of June 9th, but as the college year was about over, this did not prevent the finishing of the students' work and the closing ceremonies. Arrangements are being made to rebuild, although possibly in another location, and in the meantime recitations will be carried on in the other buildings of the R. P. I., and also, if necessary, in temporary quarters, and the president and trustees announce that the fire will not postpone the opening of the institute on September 14th, 1904, nor interfere with the regular work of the coming year, for the carrying on of which complete facilities will be afforded.

A movement is on foot to place a bronze bust of the late Professor Robert H. Thurston, temporarily in the present house of the American Society of Mechanical Engineers and permanently in the Union Engineering Building, when the latter is completed. The appropriateness of such a bust needs little argument. Professor Thurston was the first president of the society, and carried the burden of the inaugural work of its first years. As Professor of Mechanical Engineering at Stevens Institute he laid the foundation in mechanical engineering in United States technical schools, which has made them the admiration of Europe, and as the Director of Sibley College, at Cornell University, he made his impress on thousands of the younger generation of mechanical engineers. The privilege of subscribing to this memorial is not limited to members of the American Society of Mechanical Engineers, but any one wishing to take part may send his contribution to Mr. Gus C. Henning, 36 Gold Street, New York, who is the treasurer of a committee which includes also Messrs. John Fritz, Stephen W. Baldwin, R. C. Carpenter, Walter C. Kerr, E. A. Uehling and William Hewitt.

The Société des Ingénieurs Civils de France (French Society of Civil Engineers) will visit the United States this autumn. The members taking part in the excursion will leave Havre on August 20th, and will arrive in New York on August 27th. While in this country they will be divided into three parties. The itinerary of the first will comprise Niagara Falls, Pittsburg, Chicago, St. Louis, Cincinnati, Washington, Baltimore, Boston, the Berkshire Hills and New York, from which the departure for Havre will be made on September 29th. The second party will travel with the first as far as Chicago, and will then go through St. Paul to the Yellowstone Park, Salt Lake City and Colorado Springs, and then to St. Louis. The itinerary of the third party will be the same as that of the second to beyond Yellowstone Park, and will also include a trip to the Pacific Coast, where Portland, San Francisco and the Yosemite Valley will be visited. From St. Louis eastward the second and third parties will follow substantially the same route as the first, the second party sailing from New York on October 6th, and the third on October 13th. Each party will spend about a week at the St. Louis Exposition, and side trips to New Orleans and to Canada are also offered, while members may make arrangements to prolong their stay in the United States beyond the dates fixed.

—The Crocker-Wheeler Company announce that the equipment of factories with electric motors for individual and group drive of machine tools has become such an extensive department of their business that they are warranted in going a step further. They are now prepared to give their clients expert advice upon the latest ideas and re-

sults in shop practice in addition to purely engineering advice upon the design and installation of electrical apparatus for shop equipment. To this end they have retained the well-known firm of Dodge & Day, modernizing engineers, of Philadelphia, Pa. They place the services of this firm at the disposal of their customers, giving them gratuitously the benefit of its wide experience and data. The experience of the electrical engineer alone does not fully cover the numerous factors that are met in these days in the dividend-making management of machine shops. While the economies that may be effected by electric drive are conceded by all, the actual savings accomplished depend entirely upon the intelligence with which the apparatus is selected, installed and used. The advice and recommendations about which the Crocker-Wheeler Company's customers may consult Messrs. Dodge & Day need not be confined to electrical details, but may include all problems of shop equipment and management.

—Mackenzie, Quarrier & Ferguson, Inc., of 114-118 Liberty St., New York, have effected an arrangement with the Shepherd Engineering Company, of Franklin, Pa., whereby they will represent them as sales agents for the Shepherd vertical automatic steam engines. These engines are built in all sizes up to 1,500 horse power, and in simple, steeple, and cross-compound, single-valve and four-valve types. In the field of horizontal engines, Mackenzie, Quarrier & Ferguson will continue to offer the products of the Harrisburg Foundry and Machine Works, but there are many instances where the limitations of space and other conditions make the selection of a vertical engine desirable or necessary.

—The Cleveland, Cincinnati, Chicago & St. Louis Railway, popularly known as the "Big Four Route," has an interesting exhibit at the St. Louis Fair, a striking feature of which is a turntable in operation, with an express locomotive of the largest size crossing it.

—The Institution of Mechanical Engineers of Great Britain, about the time of its joint meeting in Chicago with the American Society of Mechanical Engineers, in response to an invitation of President Warren of the Allis-Chalmers Co., spent a day at the famous Allis engine works near Milwaukee, a visit which was one of the most pleasant and interesting experiences of the members of the Institution.

—The Brown Corliss Engine Company have recently increased their working capital by $150,000, which will put them in a position to carry on some of the largest work on the market. The Brown Corliss Engine Co. are building an up-to-date engine in every respect, and have one of the most modern shops in the country, and with the increased capitalization will be able to increase their business very materially.

—The Chicago office of the Nernst Lamp Company, in charge of A. E. Fleming as district manager, has been removed from 638 National Life Building, La Salle Street, to 99 East Lake Street. The new offices are larger and better equipped in every way to care for the increasing business of the company in this locality.

—Manning, Maxwell & Moore have recently been awarded the entire contract for the tools and machinery for the railway shops of the Southern Pacific Company and its branch lines, including shops at the following points: The new shop at Reno, Nev., and additions to the shops at Sacramento, Cal.; San Francisco, Cal.; Newark, Cal.; San Luis Obispo, Cal.; Los Angeles, Cal.; Oakland, Cal.; Colton, Cal.; Dunsmuir, Cal.; Fresno, Cal.; Bakersfield, Cal.; Mojave, Cal.; Ogden, Utah; El Paso, Texas; Algiers, La.; Houston, Texas; Guaymas, Mexico, and Tucson, Ariz. This is said to be the largest single machine tool order that has been placed in this country for many years. The tools are all of the latest design, and many of them are being equipped with electric motors.

—Wyman & Gordon, of Worcester, Mass., and Cleveland, O., the manufacturers of drop forgings, have issued a new number of their series of booklets, containing short stories of engineers. This one is devoted to Kristofer Polhem, a famous Swedish engineer of the 17th and 18th centuries.

—The New York Central & Hudson River Railroad, through its passenger department, has issued a new map of Asia and the Chinese Empire, in which Manchuria and the other territory forming the theatre of the Russo-Japanese war are shown on such a large scale that the reader

can readily trace the movements of the forces of both nations. This map, which is No. 28 of The Four-Track Series, has gone to all parts of the earth, and copies of it will be sent to any address on receipt of five cents, by George H. Daniels, General Passenger Agent, New York Central & Hudson River Railroad, Grand Central Station, New York.

—The New York Continental Jewell Filtration Company, of New York, have recently sold filters to H. M. Flagler, Palm Beach, Fla.; The Spring Water Carbonating Co., Boston, Mass.; J. A. Roebling's Sons Co., Trenton, N. J.; New York Public Baths, 232 West 60th street, New York City; Paducah Water Co., Paducah, Ky., the city plant; Philadelphia Hospital, Philadelphia, for the laundry; York Manufacturing Co., York, Pa., for the ice plant; Wm. Campbell Wall Paper Co., Hackensack, N. J.; The Erben-Harding Co., Tacony, Pa., for textile mills; Walcott-Campbell Spinning Co., New York Mills, N. Y.; York Manufacturing Co., Saco., Maine, textile mills; Earl & Wilson, Troy, N. Y.; Biddeford & Saco Water Co., Biddeford, Me.; Hornellsville Water Works Co., Hornellsville, N. Y.; Elmira Water, Light & Railroad Co., Elmira, N. Y. In the last three cases the filters newly ordered constitute a large increase to the plant already installed.

—The Yale & Towne Manufacturing Co., of 9-13 Murray Street, New York, have a fine exhibit of their well-known chain blocks at the St. Louis World's Fair, where they are also showing their new electric hoist.

—An arrangement between Arthur Koppel and the Baldwin Locomotive Works has just been consummated by which Arthur Koppel will be in a position to furnish Baldwin locomotives of all classes and sizes for any gauge, narrow as well as standard, and for all kinds of motive power, steam, electric, or compressed air.

—The Engineering Company of America, of 74 Broadway, New York, which have heretofore been engaged in purely professional work, have now gone into the general engineering, construction and contracting business, in addition, and are prepared to undertake all kinds of general contracting work, and desire bids from sub-contractors on such work as they have in their office, which at the present time, includes electric railroad construction, water works, powerhouses, refrigerating plants, buildings and other projects, details of which will be furnished on application.

—Allis-Chalmers-Bullock, Limited, announce that they have taken over the business and representation in Canada of the Bullock Electric Manufacturing Co., Canadian Bullock Electric Manufacturing Company, Limited, Allis-Chalmers Company, Ingersoll-Sergeant Drill Company, Lidgerwood Manufacturing Co., Wagner Electric Manufacturing Co., and Canadian Engineering Co., Limited. Their head office and works will be at Montreal, and they will have branch offices at Toronto, Winnipeg, Halifax, Vancouver, and Rossland. The new organization will operate in the closest relations to the American companies indicated, and will manufacture machinery identical in design and of the same high grade of material and workmanship.

—The Hendrick Mfg. Co., of Carbondale, Pa., one of the largest manufacturers in this country of perforated sheet metals, have concluded to open an office in New York in the Singer Building, 149 Broadway, corner of Liberty Street. Mr. C. J. Thompson, who has had a broad experience along mechanical lines, will be the resident manager, and will furnish estimates and quotations at short notice.

—The De La Vergne Refrigerating Machine Co., at the foot of East 138th street, New York, has changed its name to De La Vergne Machine Co.

—The Broderick & Bascom Rope Co., of St. Louis, have issued a complete and convenient vest-pocket map of the St. Louis Exposition, which will be mailed to inquirers on receipt of a two-cent stamp for postage.

—Harvard University offers a summer course in geological field work in Colorado, preceded by an excursion to the Grand Canyon and the Pacific Coast. The party taking this course, which will be conducted by Mr. Charles H. White, A. M., Instructor in Mining and Metallurgy, whose address is Rotch Building, Cambridge, Mass., will start from St. Louis on August 15th, and will return there toward the end of September.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Catalogue No. 35, containing illustrations and descriptions of air compressors for all capacities and all duties, of the straight-line and duplex types, simple and compound, with tables and useful information, and a view of the new works at Phillipsburg, N. J. 7 by 10 in.; pp. 71. The Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.

Catalogue, containing illustrations and descriptions of Franklin air compressors of various types and many of their parts and accessories, including intercoolers and air receivers, with directions for the installation, adjustment and care of compressors, tables of pneumatic data and other useful information. 9 by 6 in.; pp. 72. Chicago Pneumatic Tool Co., Fisher Building, Chicago.

Bulletin No. 350, containing descriptions and illustrations of stationary and portable motor-driven air compressors for continuous and intermittent service on electric railways and in other places, with diagrams and tables. 9 by 6 in.; pp. 12. National Electric Company, Milwaukee.

Miniature catalogue, illustrating and describing some of the Rand standard types of air and gas compressors, with references to rock drills, pneumatic tools and other Rand products. 6 by 3½ in.; pp. 20. Rand Drill Co., 128 Broadway, New York.

Assayers' Appliances.

Booklets and flyer, illustrating and describing power gyratory muller, disc pulverizer, radial furnaces, "coronet" rolls and other labor-saving appliances for chemists and assayers. F. W. Braun Co., Los Angeles, Cal.

Ball Bearings.

Catalogue giving descriptions and illustrations of the Reid thrust and radial ball bearings in different styles and applied in various ways, with tables and other useful information about balls. 6 by 4½ in.; pp. 47. American Ball Co., Providence, R. I.

Calipers and Dividers.

Booklet containing illustrations, descriptions and prices of toolmakers' calipers and dividers, new in design and possessing many valuable features. 6 by 3¾ in.; pp. 7. Brown & Sharpe Mfg. Co., Providence, R. I.

Contractors' Machinery.

Catalogue containing illustrations and descriptions of boilers, engines, pumps, derrick fittings, dump cars, blocks, rock drills, and many other tools, machinery and supplies for all forms of construction work. 9¾ by 7 in.; pp. 254. Harold L. Bond Company, Boston.

Cranes.

A package of sixteen cards, with illustrations and descriptions, in simple, non-technical language, of electric traveling cranes, cantilever cranes, gantry cranes, locomotive and wagon-truck cranes, crabs and winches, unloading machines and other kinds of cranes and hoisting machinery. 5½ by 3¼ in. The Brown Hoisting Machinery Co., Cleveland.

Electric Apparatus.

Illustrated bulletins Nos. 1001 to 1010, inclusive, devoted, respectively, to controllers, resistance units; brakes; solenoids and electro-magnets; fittings; lifting magnets; magnetic clutches; improved motor drive for planers; type "MT" controller; and magnetic switches. 7 by 5 in. The Electric Controller and Supply Company, Cleveland.

Electric Fans.

"The Standard" Products Book, containing several circulars, with illustrations and descriptions of desk, bracket and other styles of electric fans, and of electric motors and their applications. 10 by 8 in. The Robbins & Myers Co., Springfield, O.

Electric Machines.

Bulletin No. 1026, describing and illustrating types "H" and "HI" multipolar electric motors and generators, of open construction, and arranged for belt connection, and showing some of their applications in power houses and for driving machinery, with tables of ratings and dimensions. 9 by 6 in.; pp. 20. The Bullock Electric Mfg. Co., Cincinnati.

Electric Motors.

Bulletin No. 219, illustrating and describing "round-type," enclosed, direct-current motors and their application to machine driving, hoisting, pumping and various other purposes, with table of dimensions. 10¾ by 8 in.; pp. 16. Sprague Electric Company, 527 W. 34th St., New York.

Electric Works.

Tastefully decorated pamphlet describing the works of the Westinghouse Electric & Manufacturing Co., their industrial and sociological aspect, and some of the remarkable apparatus produced there, fully illustrated from photographs. 9½ by 7½ in.; pp. 44. Westinghouse Electric & Manufacturing Co., Pittsburg.

Feed-Water Heaters.

Bulletin B 68, with illustrated description of the Blake-Knowles multi-current feed-water heater, in which the heat-transmitting surfaces and the direction of the currents of water and steam are so designed as to greatly increase the efficiency. 9 by 6 in.; pp. 4. International Steam Pump Co., 114-118 Liberty St., New York.

Hose Couplings.

Pamphlet No. 5, illustrating and describing the "Quick as Wink" coupler for air, steam or gas hose, used with pneumatic tools and for other purposes, which has tight joints that swivel, and can be very quickly and conveniently applied and removed. 9 by 6 in.; pp. 12. Also, pamphlet No. 6, showing the application of this coupler to water hose. 9 by 6 in.; pp. 12. The W. J. Clark Company, Salem, O.

Locomotives.

Supplement No. 2 to catalogue No. 77, with illustrations of many styles of Baldwin locomotives for narrow, as well as standard, gauges. 10 by 8 in.; pp. 6. Arthur Koppel, 66-68 Broad St., New York.

Machine Tools.

Catalogue, containing illustrated descriptions of automatic chucking and turning machines, lever chuck, double-turret lathes, manufacturing lathes, universal shaping machines, and other machine tools. 6 by 9 in.; pp. 52. Potter & Johnston Machine Co., Pawtucket, R. I.

Portland Cement.

Pamphlet, containing description of "Dragon" Portland cement and its manufacture, directions for testing, results of tests, uses for which it is adapted, list of users, information about mortar, cement and concrete, testimonials and other matter. 8 by 5 in.; pp. 81. The Lawrence Cement Co., 1 Broadway, New York.

Pumps.

Catalogue No. 16, containing illustrations and brief description of special high-duty and mine pumps, with table giving code words, dimensions and prices. 3½ by 6 in.; pp. 6. The National Steam Pump Co., Upper Sandusky, O.

Reinforced Concrete.

Booklet entitled "Twisted Steel," showing how the Ransome twisted bars are used in all kinds of reinforced-concrete construction, with illustrations, diagrams and formulae. 6 by 3½ in.; pp. 20. Ransome Concrete Machinery Co., 11 Broadway, New York.

Renold Chain.

Booklet No. 39, 1904, containing illustrations and descriptions of the Renold Silent Chain Gear, and its application to many kinds of power transmission. In its latest style, the wear is transferred from the hole of the link to a case-hardened bushing, so that the chain is practically non-elongating. 7½ by 3¾ in.; pp. 34. The Link-Belt Engineering Co., Nicetown, Philadelphia.

Riveters.

Catalogue No. 3, containing descriptions and illustrations of portable and stationary pneumatic compression yoke riveters for bridge, boiler, tank, shipbuilding, and all other structural iron and steel construction. 9 by 6 in.; pp. 16. Hanna Engineering Works, 820 Elston Ave., Chicago.

Seamless Pipe.

Large pamphlet, with well illustrated description of the Bartlett-Kent process for rolling seamless steel pipe, and an account of the organization of a company and the laying out of a plant for its manufacture. 13 by 10 in.; pp. 16. Seamless Rolled Steel Pipe Co., Chester, Pa.

Steam Engines.

Large pamphlet, with half-tone illustrations, line drawings and description of the new Hamilton-Corliss vertical cross-compound steam engine and its details. 12 by 9¼ in.; pp. 16. The Hooven, Owens, Rentschler Co., Hamilton, O.

Catalogue, containing illustrations and descriptions of Fulton-Corliss steam engines, in various styles, and their parts, with views of plants where they are installed, directions for the adjustment of Corliss valve gear, tables of indicated horse power of compound engines, and other useful information. 6¾ by 10½ in.; pp. 61. Fulton Iron Works, St. Louis.

Series E-1 catalogue, with descriptions and illustrations of enclosed and automatic steam engines, direct connected and belted, and their parts and accessories. These engines are built in accordance with the standards of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers for direct-connected generating sets, and possess many useful and valuable features. 6 by 9 in.; pp. 26. Chandler & Taylor Company, Indidanapolis.

Steel Cars.

Cloth-bound book, with descriptions of hopper, gondola, and other styles of steel cars made with structural shapes, illustrated from photographs of cars in use by some of the leading railroads. 6 by 9 in.; pp. 34. Cambria Steel Co., Philadelphia.

Storage Batteries.

Bulletins Nos. 82 and 83, devoted respectively to "The Storage Battery in Small Central Stations," by J. M. S. Waring, reprinted from *The Central Station*, and to "The Chloride Accumulator in Connection with the Exciter Circuits of Large Alternating-Current Generating Stations," with illustrations. 10½ by 8 in.; pp 4 and 6. The Electric Storage Battery Co., Philadelphia.

Transformers.

Pamphlet No. 9127, entitled "Fifteen Years' Experience in Transformer Practice," giving an illustrated account of the development in the manufacture of transformers by the General Electric Company, culminating in the improved designs of their Type H core transformer. 7¾ by 5¼ in.; pp. 16. General Electric Company, Schenectady, N. Y.

Water Wheels.

Bulletin No. 5, containing illustrations and descriptions of the Doble tangential water wheels and some of their parts and accessories, including ellipsoidal buckets, needle regulating nozzles, wheel housings, and ring-oiling bearings, with useful hydraulic tables. 4½ by 7 in.; pp. 46. Abner Doble Company, San Francisco.

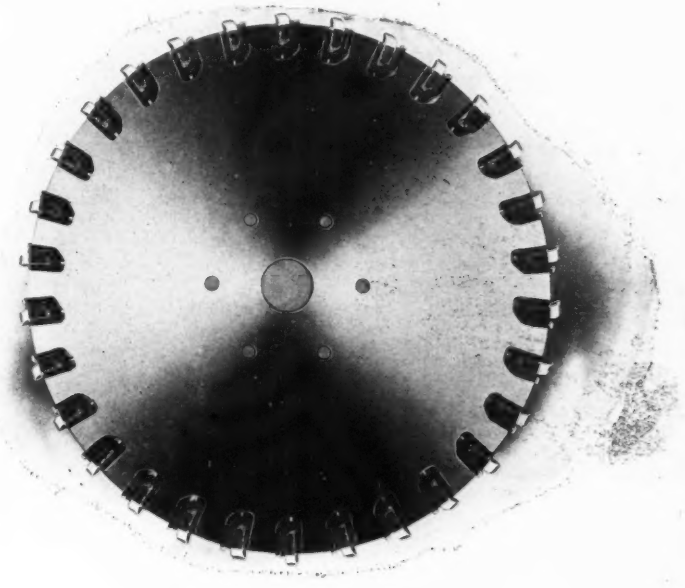
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Taylor-Newbold Metal Saw.

A METAL-CUTTING saw, which is attracting universal attention at the present time, is the invention of Fred. W. Taylor and Sidney Newbold of Philadelphia, the essential feature of which is the use of inserted cutters treated under exclusive rights for these saws by the Taylor-White process.



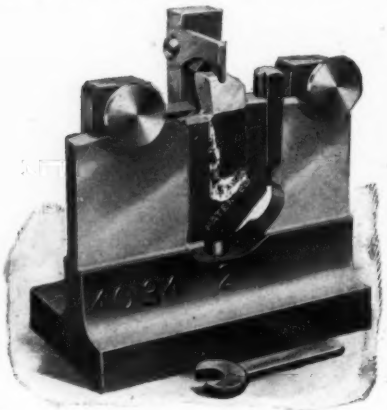
TAYLOR-NEWBOLD METAL SAW.

Figure 1 gives a view of a 36-inch saw carrying thirty cutters. It will be noticed that the cutter proper is carried in a U-shaped holder, which is more clearly shown in the view of the setting gauge, Figure 2. These cutters are made of air-hardening steel treated as above, and secured in the holders by fusible metal poured in a groove which is symmetrical and central in both the holder and the cutter, thus locking the two together. The back of the cutter which receives the thrust of the cut rests metal to metal against the holder, while an excess of the fusible metal takes up the space between the front side and the cutter.

Referring now to Figure 2, it will be observed that the holder carries tapped in it an adjusting screw. The setting gauge consists mainly of a cast iron counterpart of the rim of the saw with one of the cutter and holder slots included. After the cutter has been ground in a special socket, it is adjusted to its proper cutting height by turning the adjusting screw, while the cutter holder occupies its normal position in

the setting gauge, the sliding surface gauge, with its two projecting pins, shown in Figure 2, being used for that purpose. It will be observed that the cutter holder is grooved back and front, as is also the slot in the saw blade, and the cutters are secured in the blade by driving a tongued wedge behind the holder while the adjusting screw rests in proper contact with the base of the slot in the blade.

The thirty cutters in a 36-inch saw may be removed when dulled, and a new set of cutters inserted in from twelve to fifteen minutes, thus accomplishing what is practically regrinding the saw without removing the blade from the machine. In regular service, on forgings varying from 25 to 50 carbon, these cutters do not require grinding oftener than once in two weeks,



SETTING GAUGE FOR CUTTERS OF TAYLOR-NEWBOLD METAL SAW.

running both night and day, or over three hundred hours of actual work, and then the majority of the cutters might easily run two weeks more. This is after cutting steel forgings of all descriptions at a speed of 90 feet per minute, throwing off perfectly blue chips, and advancing from 1 inch to 1¼ inches per minute, according to the section and hardness of the work, and solely depending upon the power of the machine to drive the saw and feed it.

Chips which are cut from 12-inch Krupp armor, 1.88 carbon, by an 84-inch saw advancing 40 inches an hour through the plate, are so hot as they leave the cutters that, when two of them touch, they often weld together, by their own heat. The capacity of these metal-cutting saws is so great that, at present, there are no machines capable of utilizing all of it, although it is highly creditable to our machine-tool makers that their machines, with the Taylor-Newbold saw, are standing up to a duty, thrust upon them unexpectedly, from eight to ten times what was required by the tempered saw blades for which they were designed.

These saws are manufactured by the Tabor Manufacturing Company, of Philadelphia, who will be pleased to supply any further information which may be desired.

Hanna Compression Yoke Riveter.

RIVETING machines may be divided into four general classes, depending upon the fluid used in their operation and the manner of applying pressure to the riveting die, under the heads of hydraulic, hydro-pneumatic, pneumatic-lever and pneumatic toggle-joint machines.

The last class is most generally used and is satisfactory in many respects, but at the latter part of their stroke the leverage of the toggle-joint machines changes too rapidly, and there is uncertainty as to their proper operation.

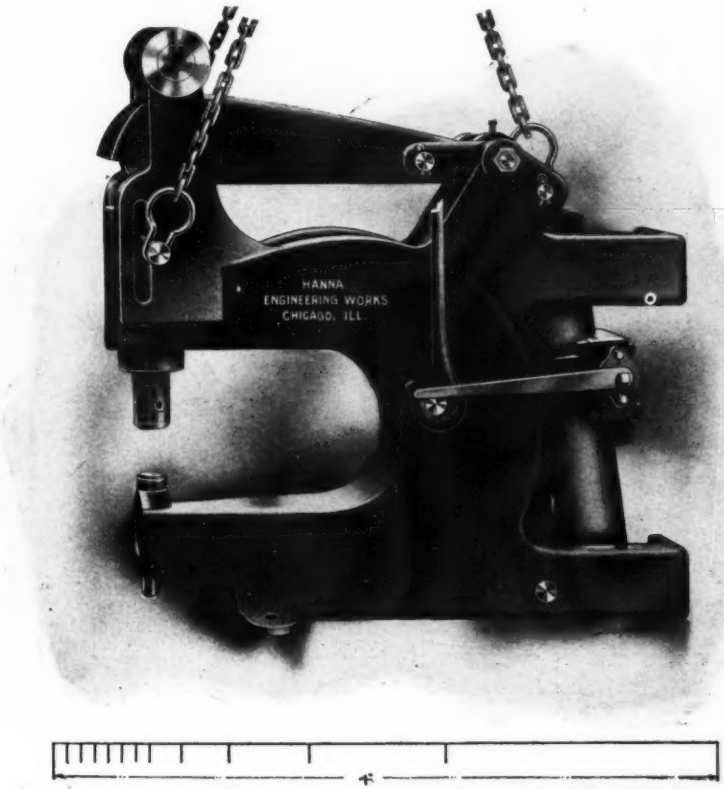
In the Hanna pneumatic compression yoke riveter, which is a modification of the toggle-joint machines, their defects have been successfully overcome. The movement of the Hanna riveter combines, in a simple form, toggles, levers and guide links to give the large opening of the toggle-joint movement with its gradually increasing pressure until the desired pressure is reached, then a simple lever movement throughout a considerable space under uniform maximum pressure. This space, where a uniform maximum pressure is available, is sufficient to avoid any uncertainty about the pressure applied on the rivet; and the machine once adjusted for a certain length of rivet and thickness of plate will require no further adjustment for ordinary variation in lengths of rivet, heat or thickness of plates.

All machines have the automatic cut-off for air on the return stroke adjustable to cut off at such a point as will just return the piston to its extreme position. This is an important feature in the saving of air and

taking the pressure off the trunk packing. The controlling valves are plain slide valves, with stems self packing. The air piston is cushioned at each end.

With the lattice riveter and the small sized yoke riveter a chain suspension is furnished by which the top riveting die is held stationary relative to the work and suspended in any position from horizontal to vertical and all the larger machines have feet cast on the frame for supporting them as stationary machines in a vertical position.

The number of rivets which these machines will drive is usually limited only by the heating arrangements.



19-INCH HANNA COMPRESSION YOKE RIVETER.

surrounding objects, the whole frame moving up and down. This enables the machine to drive rivets from the bottom without reversing it, a great convenience for lattice and cover work.

Each machine is furnished with suspension yoke, oiling devices and one set of riveting dies, as selected by the purchaser.

All the portable machines can be operated

The heading of rivets on the under side of the work, and the fact that only one squeeze is required to set with certainty any rivet are special advantages possessed by the Hanna riveter, which are of the highest importance for fast and economical work.

Besides being used for a riveter, any of these machines can be fitted with attachments for bolt heading, punching, shearing

and bending, all of which have been successfully accomplished, and any further information desired will be gladly furnished by the manufacturers, the Hanna Engineering Works, of 820 Elston Ave., Chicago.

The Ridgway Two-Belt Conveyor System.

THE extent to which belt conveying has become a factor in modern engineering practice, makes any radical departure, especially in the line of improvement, particularly interesting to the engineering world.

Belt conveyors have been heretofore designed on the fundamental principle of causing the belt to be troughed or cupped, and this has been accomplished by using concentrators, either independently of the horizontal carrying pulley, or in various combinations.

In any type of three-pulley carrier, the bottom pulley horizontal and the side pulleys at varying angles, the belt is forced (by the weight of the load when it conforms to the outline of the carriers) to make a more or less sharp bend where the horizontal and angle pulleys meet, and all the strain is concentrated on two points. Again, the three-pulley type of carrier requires that the pulleys be loose on the shafts, so that the friction surface is very great and the tendency of the side rollers is to wear in such a manner as to produce in time a gyrating motion. The tendency of the belt to flatten out between the carriers can only be obviated by placing the carriers very close together, in which case the cost would necessarily be excessive.

In the two-belt system an interior troughing and supporting belt runs over its individual head and tail pulleys, having separate take-ups, and is entirely independent of the conveying belt proper. The conveying belt is threaded over its head and tail pulleys in the usual manner and has its separate take-up so that the two belts, although moving together in the same direction at the same speed, are entirely separate and distinct, and this enables the conveying belt to be lifted off the supporting belt and out of the troughing blocks and passed through either a stationary dumper or a movable tripper.

The conveying belt has no work put upon it other than what is required to drive the lower carriages and its own head and tail

RIDGWAY TWO-BELT CONVEYOR: ROLLERS FOR CARRYING INNER BELT.

pulleys; all the carriers on the upper line, which comprise two-thirds of the total number used, being revolved by the inner supporting belt. The strains, therefore, are divided, the belt revolving two-thirds of the moving parts not being subject to the wear and tear of carrying the load, and the belt carrying the load being relieved of the strains and wear and tear of revolving the majority of the moving parts of the machine. This produces a divided labor in wear and tear which enables both belts combined to only represent in strength what would be required of one belt in any one-belt system.

of concentrating rolls lifts the edge of the belt and drops it into the troughing blocks. This same method is used where the conveying belt leaves the troughing blocks at the opposite end.

One of the illustrations shows the carriers used in the two-belt system. They are straight rollers fastened to steel shafts revolving in babbitted boxes, the boxes being ball-and-socket, ring-oiling, felt-washered, and dust-proof. By this method not only is first cost reduced, but power is saved and the labor of supervision cut out entirely as far as the factor of lubrication is concerned. In the two-belt system the

TWO-BELT CONVEYOR: INNER BELT IN POSITION WITH TROUGHING BLOCKS ATTACHED.

The interior belt is driven by a compensating roller or block chain sprocket drive from the main driving shaft, and with the two belts in tension just sufficient to prevent slip on their driving pulleys; both belts move at exactly the same speed in the same direction and there is no rub of the conveying belt on the troughing blocks. At the points where the conveying belt meets the interior supporting belt, in order to prevent the rub and wear caused by the troughing blocks moving in a larger radius (the conveying belt being at the same height as the centre of the supporting belt) a pair carrier belt, or conveying belt proper, lies in a natural position, a true segment of a circle, with the strains distributed over its whole width uniformly. This greatly increases the life of the belt.

The interior troughing and carrying belt with its troughing blocks attached, is shown in the other illustration.

This two-belt conveyor system has been in very successful use in the concrete plant at the great Washington filtration works, and further information about it will be cheerfully given by the Ridgway Belt Conveyor Co., of 29 Broadway, New York.

The Standard Auto-Addresser.

LABOR-SAVING apparatus has become a necessity in the office as well as in the factory. The typewriter, the telephone, the card-index and other devices are relieving office work of much of its drudgery and saving a vast amount of time. Where a business house has a long mailing list, it becomes of great importance to address the letters, circulars, publications or other matter with the least expenditure of time and labor, and several machines have been devised to do this work.

HAND-FEED STANDARD AUTO-ADDRESSER.

One of the newest and best of these is the Standard auto-addresser, which possesses a number of special advantages. This machine can be used for addressing all kinds of matter, and can also be provided with a wrapper-cutting attachment.

It occupies but little room, and may be placed on a desk or table, as shown in the accompanying illustration, so that it can find a place in even a small office, and it requires only ordinary care in its operation. It can be driven by foot power or electric motor, and is practically noiseless.

The printing is done from perforated cards, which are made by attaching parchment to a pasteboard frame. These cards are written on an ordinary typewriter, set with special needle type. If necessary, six lines can be typewritten on each card.

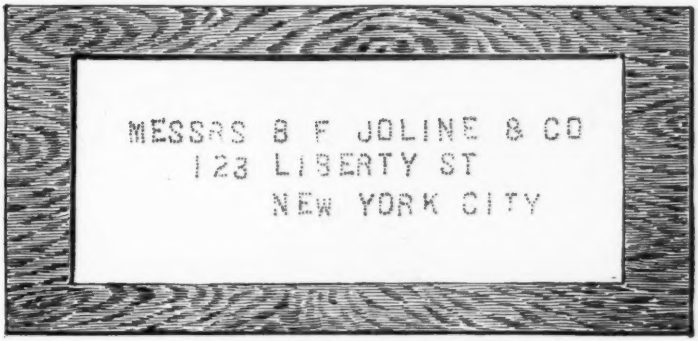
The perforated cards are placed in light metal hoppers twenty inches long, each holding four hundred cards. The hoppers, with the cards systematically arranged, may be filed in cabinets, and their use obviates any handling of cards, except when the latter are to be changed or new ones added.

The hopper holding the perforated cards from which the addresses are to be made is placed in the rear magazine. A light weight is laid on the top of the cards to carry them downward. When they strike the lifting table, the first card is caught by two steel card carriers and brought forward. It is impossible for more than one card to be carried from the rear hopper at a time. By the time three cards are carried forward the front one is in the proper position and the impression is made. Then the card is carried upward by the lifting table above the spring card catchers into another hopper placed in the front maga-

zine. The card which has been used is securely held in the front magazine before the card carriers can bring forward another. It will thus be readily seen that duplicating is absolutely impossible. If more than one of the same address is required additional cards must be added.

The cards are kept clean by a special action of the rubber rollers. If the instructions are followed, it is guaranteed that the perforations in the cards will not clog or stop up. This is borne out by the fact that thousands of impressions have been made from a single card, and even after months of disuse, perfect work can be done.

With either foot power or a one-twelfth horse-power electric motor, the auto-addresser may be driven for hand feed at the rate of from twenty-five to sixty-five addresses per minute. An office boy or girl of ordinary intelligence can work at the rate of three thousand addresses per hour, while with the automatic envelope feed seven thousand envelopes per hour can be addressed.



EXACT SIZE OF THE CARD OF THE STANDARD AUTO-ADDRESSER.

In order to meet a demand for an addressing machine with a wrapper-cutting attachment which can be removed at will, the combination Standard auto-addresser has been brought out. This machine is mounted on a substantial iron bed plate and supported by four iron legs. It can be operated by a direct-connected one-fourth horse-power electric motor, or from a shaft by belting, and the paper is fed from a roll. As an automatic-feed machine operated by a direct electric motor, it has a speed of one hundred and twenty impressions per minute, which can be reduced by a regulator to forty-five impressions per minute, so as to be used for hand feed.

Wrappers varying from six to sixteen inches in width and from five to twenty inches in length can be cut with the auto-addresser cutter, and the adjustments can be easily made.

The wrapper-cutter attachment can be readily removed, and envelopes, wrappers, billheads, and similar matter may then be fed by hand.

Further information concernings this addressing machine may be obtained from B. F. Joline & Co., of 123 Liberty St., New York.

Universal Shaping Machine.

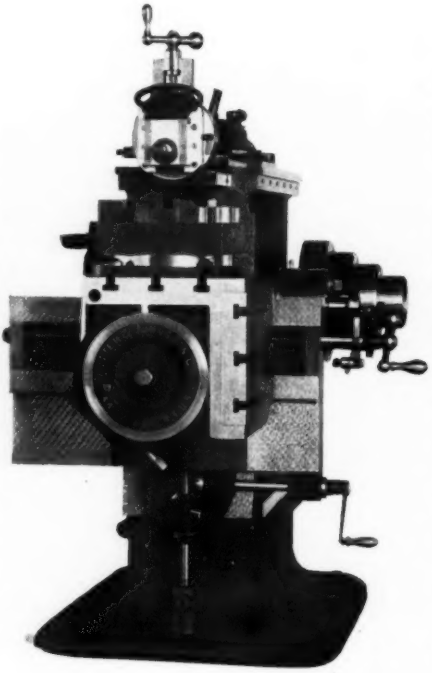
THE shaping machine shown in the accompanying illustration possesses several unique and valuable features and bears much the same relation to the ordinary shaping machine that the universal milling machine does to the plain milling machine.

The down feed and automatic stop to the tool slide are very efficient and will not get out of order, as the mechanism is very simple. There are ten changes of down feed and the automatic stop can be set in any position. The feed can be changed and the stroke of the ram positioned while the machine is in operation. The machine is made with either plain or swivel table, the former having on three sides tee slots to which work can be bolted, while the swivel table revolves in either direction through an arc of ninety degrees, and is graduated in front, so that, using the power-cross

feed, pieces can be planed exactly to any angle without tentative setting. The swivel table is revolved by worm gear with rotary adjustment, and may be fitted with one auxiliary tilting table, which is a particularly handy attachment for die work and tool making. Both the tool-slide feed screw and the table feed screw have graduated collars for fine adjustments.

The shaper illustrated is the 15-inch machine, but there is also a 24-inch size made, in which the table is raised and lowered by power.

The ram has quick return, and is of strong construction and of great length. The ram slide is unusually long; the cross slide is very deep and scraped to an accurate bearing, thus insuring accurate planning to the extreme limit of the stroke. A graduated dial enables the ram to be set at any desired length of stroke, and can be positioned while the machine is in motion. This enables the operator to work to an irregular line. The cross slide is mounted on ball bearings, and is easily and quickly elevated and lowered. The cross slide feed screw, and also the tool head feed screw, have graduated collars for fine adjustments.



POTTER AND JOHNSTON UNIVERSAL SHAPER.

The tool slide has a substantial down feed and automatic stop at any angle through an arc of 90 degrees, and has ten changes of feed, which can be changed instantly from one feed to another while the machine is in motion; this is accomplished by throwing the index finger to the left or to the right, and allowing the spring pin in the finger to engage in the desired hole in the face of the disk, upon which index finger rotates. When the pin is in the lower left-hand hole the feed is at zero. The down-feed motion is controlled by the location of a knurled screw, which is set in a radial slot in the side of the ram, and engages the stop finger. This arrangement is positive and will stop the feed to any degree of accuracy, a feature which will commend itself to all mechanics, as it enables the workman to do other work while the machine is in operation. On the opposite side of the machine from that shown in the cut there is a convenient door, tool shelf and cupboard.

The vise is strongly and accurately constructed, and is arranged to draw the work down when gripped, thus holding the piece firmly and insuring parallel work. The jaws are made of hardened steel, one of which is V shaped and swivels to present that or the straight face to the work. It has a circular graduated base, and the work may be adjusted to any horizontal angle. The actuating screw and nut are thoroughly protected from chips and dirt. Index centers are designed to be gripped in the vise, and as its base is circular and graduated, the centers can be adjusted to any angle.

The countershaft is supported in very strong hangers of neat design. The bearings are ground and run in the most approved self-oiling bearings.

Further particulars regarding these shapers will be gladly given by the manufacturers, the Potter and Johnston Machine Co., Pawtucket, R. I.

Vertical Boring Mill.

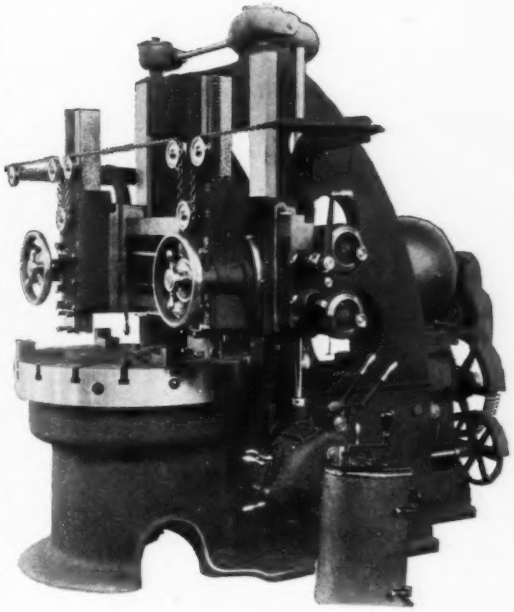
A SOMEWHAT radical departure from the usual type of vertical boring mills is shown here, the product of the Gisholt Machine Company, which has recently entered the boring-mill field. This company has heretofore been principally engaged in the manufacture of turret lathes, and the success of certain features in those lathes led to the embodying of similar principles in boring mills.

Possibly the most noticeable departure from former types is in the headstock, the absence of the familiar cone pulley being a conspicuous feature. The drive is of the single-pulley, constant-speed variety, heretofore considered only suitable for small machines, but its adaptation to this tool has proven it a most successful drive for larger machines as well.

The spindle rests on a broad self-oiling babbitted surface, giving great rigidity to the table. The table itself is powerfully geared, being driven by spur pinion. There may be a universal combination chuck, fitted with three movable top-jaws, or a face plate with independent jaws can be substituted when desired.

The headstock is friction back geared, being constructed on the same principle so successfully used by this company in its turret lathes. Complete control of the table is most conveniently given by this form of headstock. The operator has control of all driving mechanism from either side of the table, and may start or stop it without stopping a motor or shifting a belt. It is often advisable to move the table a fractional part of a revolution for the adjustment of tools, and with this style of headstock the operator may move the table the required distance by a simple movement of a lever, without the necessity of running the belt by hand, as is customary with the ordinary form of drive. The headstock is so designed that a variable-speed motor with an increase of 50 per cent. above normal will give an almost ideal arrangement of speeds, and in consequence there is required but a moderate-priced motor equipment.

The number of mechanical speeds given by this form of headstock is six. The convenience of the operating levers is a very noticeable feature. An arrangement which enables the operator to control his machine absolutely without moving from his customary position makes it a very attractive machine to the operator, and at the same time a great time saver.



GISHOLT VERTICAL BORING MILL.

Another time-saving feature is the method of controlling the feeds. All feeds are fitted with micrometer dials indexed to .0010 inch, which enables the person operating the machine to set the tool with the greatest accuracy. By such an arrangement the time required in measuring and calipering is very materially lessened. In connection with the micrometer dials the automatic tripping device enables the operator to set the machine accurately at any point he may desire, and be sure of the cut stopping at that point. This arrangement of micrometer dials and tripping devices is on all feeds,

and is a most convenient and time saving feature. The feeds, both vertical and horizontal, are operated by power or hand and a range of ten feeds is given. The heads are absolutely independent and controlled from either side of the machine. There is a positive stop to each head so that the center of the down slide may be brought to coincide with the center of the table. The down slides are of a particularly stiff construction, and taper gibs on broad unbroken surfaces are provided for taking up the wear. All the standard machines are so arranged that the right-hand head may be removed when desired and replaced by a turret and screw-cutting bracket. The turret slide is provided with the same automatic trip heretofore spoken of and may be swung to any angle. The cross rail is of a very rigid construction, and of course is raised and lowered by power.

Recognizing the modern necessity for having machine tools adjustable to motor drive, considerable attention has been given to that feature. The result is a design permitting of motor attachment either direct or by chain or belt, and without increase of floor space.

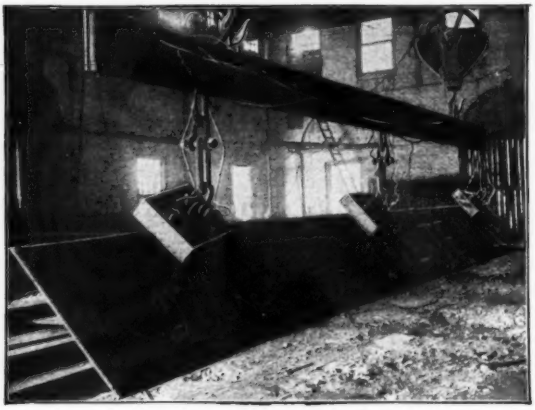
In general appearance the mill is massive and yet presents a neat and attractive design, showing sufficient metal in it to withstand the heaviest cuts attending the use of high speed steel.

Further information concerning these tools will be gladly given by the Gisholt Machine Company, of Madison, Wis.

Lifting Magnets.

THE economical handling of materials is a very important feature in the operation of works, and there has been a great increase of late years in the installation of cranes and other hoisting and handling apparatus, among the latest of which is the lifting magnet.

The principle of the lifting magnet has, of course, been known for a long time, but although this apparatus is especially adapted to the handling of iron and steel plates, pig iron and many other iron and steel products, it is only recently that it has been commercially applied, The Electric Controller & Supply Co. being particularly active in this field.



LIFTING MAGNET FOR PLATES.

In all cases an electro-magnet is used, suspended from the hook of an electric, steam, pneumatic or hydraulic crane; direct current at any of the common voltages of distribution being employed for energizing the magnet. Flexible cables are used for conveying current to the magnet, and the only additional apparatus in general required for the operation of the magnet consists of a small switch for connecting and disconnecting the winding of the magnet from the source of current supply.

In operation, the magnet is lowered upon the material to be lifted, and the switch closed, thus causing the magnet to attract and hold the material, which may then be hoisted by the crane and transported to the desired point. By simply opening the switch the material is instantly released.

Comparing this method of operation with the common methods of connecting the load to the hook of the crane, with chains, hooks or clamps, the saving in both labor and time is apparent, as, in general, the attachment of the magnet to the load, as well as the release of the load, may be accomplished by the crane operator without assistance, thus saving the labor of one or more men for prying up the material, attaching hooks and chains at the point of

loading and additional men at the point of delivery for unhooking the load from the crane.

Magnets can be so quickly attached to and detached from a load that by their use the work which may be done by a given crane is greatly increased, in some cases more than doubled. It frequently occurs that the attachment of lifting magnets to existing cranes so increases their capacity for handling material that the purchase of additional cranes for handling an increased output is rendered necessary.

Again, lifting magnets require much less headroom than hooks or chains for lifting material of considerable width such as plates. Therefore, by the use of magnets material can be conveniently piled to a greater height in the storage space under a given crane than is possible when chains are used, thus increasing the capacity of a given storage space without altering the crane runway or increasing the size of the building.

While lifting magnets may be used to great advantage in the handling of pig iron, ingots, blooms, slabs, billets, bars, plates, rails, structural shapes, iron and steel pipe, and many other raw and manufactured products of iron and steel, a single design of magnet is not adapted to all these purposes. On the contrary, the magnet must in every case be designed to meet the form of material to be handled, and, in order that this may be done to the best advantage, standard forms of specification sheets have been prepared, which, together with other information, will be forwarded upon request by The Electric Controller and Supply Co., of Cleveland, to any one contemplating the installation of magnets.

LIFTING MAGNET FOR PIG IRON.

Farwell Milling Attachment.

AMONG the many successful ways of using the Farwell miller, and the most recent, is the one shown in the accompanying illustration, where the machine is at work hobbing bronze worm wheels.

The bronze blank is properly set on the revolving table, which is turned at proper speed to allow the hob to be fed into the blank without first being slashed with a single cutter. The table is driven by a worm which engages the teeth on the edge of the table. Gears of proper ratio between hob and worm insure the correct speed of the table. By changing the hob, blank, and gears a great variety of worm wheels may be cut.

In The Adams Company's shop, where the Farwell miller is made, this method of cutting worm wheels is employed on four sizes of wheels, two of which are cut with single-thread hob and two with double-thread hob. The miller is designed for use

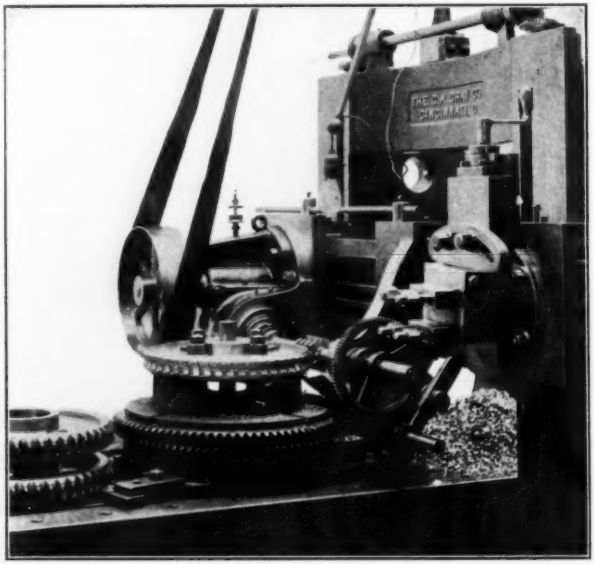
in combination with the planer and is made in four sizes.

The Farwell miller is radically different from other milling machines, the leading points of difference being as follows: It is not a complete, independent machine in itself, but is a device to be used in combination with the planer, and enables the operator to do planing, milling and boring on the planer, and at one setting of the work, thereby providing a combination tool of great range and flexibility. In this connection it may be said that if every planer were fitted out with this milling outfit there would be no idle planers. Another distinctive feature is that the head swivels on the saddle, so enabling the operator to do vertical, horizontal and angular milling with the one head, and greatly increasing the usefulness of the tool.

The spindle, which is of steel, runs in long bronze boxes of special design, and is driven by a bronze worm wheel engaging with a steel worm. A taper hole extends from each end of the spindle to the center, so that either end of the spindle may be used. A recess in each end of the spindle forms a clutch which engages with the arbor. Ball-bearing thrust collars take care of the end thrust on the worm when heavy cuts are being made, and the worm wheel runs in oil.

The illustration shows a novel and highly successful adaptation of this combination miller and planer, and when it is considered that very few shops have enough worm wheels—and many other machine parts as well—to make to justify the installation of a special machine for them, this combination will be appreciated.

Further information concerning this milling attachment will be gladly furnished by The Adams Company, of Dubuque, Iowa.



FARWELL MILLING ATTACHMENT.

The Browning Locomotive Crane.

MOST people consider that if they buy a machine which pays for itself in four or five years' time, they have made a profitable investment, but a locomotive crane, as made by The Browning Engineering Company, pays for itself in six months, if used continuously eight hours per day. It pays for itself in this time when used in any of the classes of work for which it is adapted, such as moving heavy material to and from cars or wagons, as a switching engine, handling coal by means of a clam-shell bucket, piling lumber, logs, structural material, stone, castings, heavy flasks, and

so on in a storage yard, and many other operations.

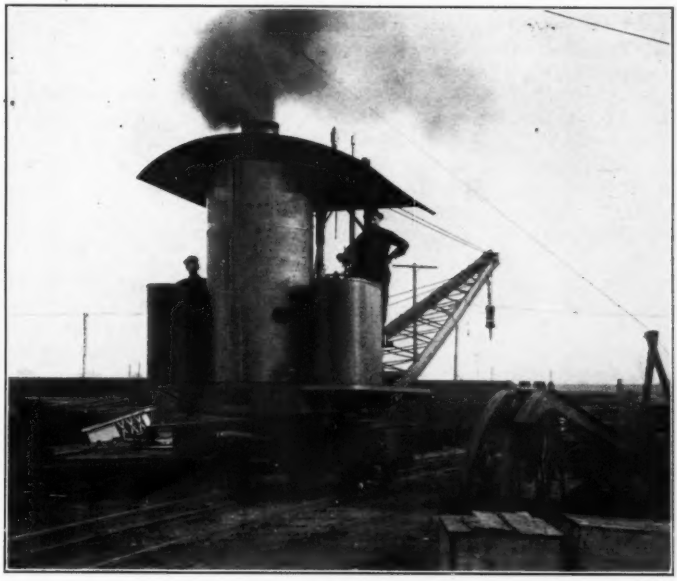
The labor saved is that of from fifteen to twenty-five men. Where it used to take a certain railroad two days to move heavy timber from a gondola car and pile it beside a track, using eight men, it now takes four men five hours to do the same work with a crane, and the timber can be piled twenty feet high instead of four feet, so that with the crane four-fifths of the yard room is saved.

Using a Browning clam-shell bucket of two cubic yards capacity and a locomotive crane, a gondola car of coal can be unloaded in forty minutes, or fifteen cars of forty tons capacity (six hundred tons in all) per day of ten hours.

A locomotive crane consumes about a quarter ton of coal per day, and assuming six per cent. on the cost of the crane and $2.00 per day for an operator, the cost of operating a crane is $4.05 per day, so that it may be readily seen that firms using such a crane have a decided advantage over their competitors, both in making estimates and in delivery.

The Browning locomotive crane consists of a traveling truck with axles geared, carrying upon its upper surface the rotating base and operating machinery. The construction is exceptionally heavy, the operating machinery, including boiler, being carried on the single casting of the rotating base, and the gears being of steel with cut teeth.

The power is derived from two vertical engines connected at ninety degrees, and the various motions of hoisting, radius varying, rotating and traveling are controlled through clutches. The clutch is of a patented special type, made of hardened steel, and so constructed that the greater the power transmitted, the more firmly will the clutch engage.



BROWNING LOCOMOTIVE CRANE.

The operating levers are so arranged that the engineer can have a clear view of his machinery and of the operations of the crane and yet be near enough to the boiler for firing.

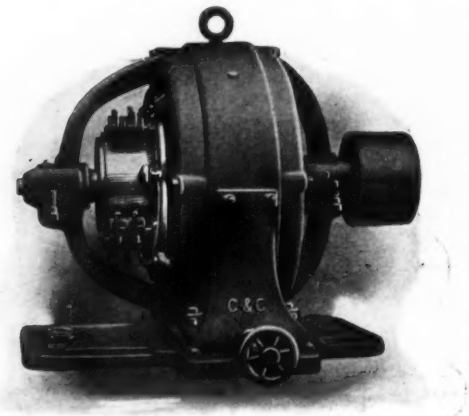
The Browning standard locomotive crane is made throughout in accordance with the best engineering practice, and further particulars regarding it will be gladly given by The Browning Engineering Company, of Cleveland.

"C & C" Motors and Dynamos.

A NEW line of direct-current dynamos and motors, which possesses a great many novel and interesting features, notable among which are the means employed for securing very low temperature increases and great overload capacity, has just been placed on the market by The C & C Electric Company of New York.

The type "S" machines are made in the standard sizes from 2 to 50 horse power in all the various styles. They were especially designed for operating machine tools and machines requiring a wide range of speed control, and for heavy overload capacity. The symmetrical and graceful appearance of the machine is shown in the illustrations.

The magnet frame, together with its brackets or supports, and the pole pieces, are of a special grade of soft cast steel, while the brackets which carry the bearings and the finishing rings are of cast iron. The bearings are of the self-oiling, self-aligning type; the field coils are wound on metal bobbins and are readily removable;



C & C OPEN STYLE MOTOR.

the brush holders, which carry carbon brushes, are of the C & C Company's well known "reaction" type, and are supported rigidly from the front bracket finishing ring by means of an insulated cast iron ring. The brush holders are thus not only firmly supported, but their position can readily be changed by revolving the ring.

It is in the armature construction especially that the very satisfactory results are accomplished. The armature is large in diameter, and comparatively short, and its core, which is composed of special soft-steel laminæ, is of the slotted hollow-drum type,

C & C CLOSED STYLE MOTOR.

and is built up directly on the armature shaft. The form of the laminæ is such that three tunnels are provided parallel to the shaft, which run entirely through the armature body. A spacing star, or ventilating spider, is placed in one position, or sometimes in two positions, in the armature core, and the arms of this star intersect the tunnels. The armature end plates are also of the spider construction, as is the commutator shell, the arms of all of which radiate from the shaft in such fashion that when the armature is in motion, the various spiders act as the vanes of a fan, with the result that there is a tremendous rush of air through the armature, some of it being deflected by the spacing spider, and sprayed against the pole pieces and field coils. The effect of this forced circulation of air is to keep the machine remarkably cool. The armature coils are form-wound, and are retained in their slots by means of wooden wedges, without the use of bands.

The commutator is very large in diameter, of very broad face and is intended to last at least twenty years.

These machines have been so carefully designed, so liberally proportioned, and are so thoroughly ventilated that the C & C Electric Co. guarantees that after a twenty-four-hour, full-load run, no part of the machine will show a temperature rise ex-

ceeding 30° C. above the temperature of the surrounding atmosphere; and the machines will stand 100 per cent. overloads for one half hour without injury. The machines run absolutely sparklessly at all loads up to 50 per cent. overload.

With standard windings and at their standard ratings, the machines are capable of a speed variation of from 50 to 75 per cent. by means of field regulation; or with special windings, from 75 to 100 per cent. By specially winding a machine of given power on a somewhat larger frame, speed variations as high as four to one are obtained, and by furnishing the motor in the double-commutator type, the speed ratios are doubled.

The C & C Electric Co., of 143 Liberty St., New York, can be addressed for their descriptive bulletin No. 151 T, which contains illustrations and full particulars of these machines.

Automatic Band Rip Saw.

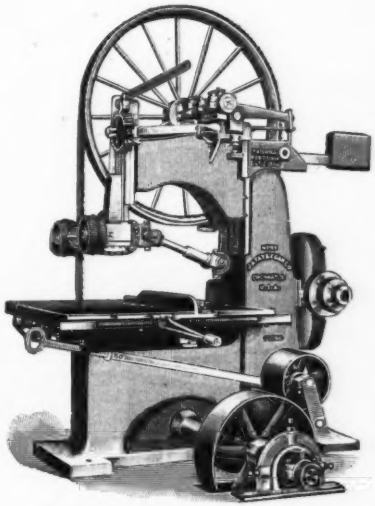
TO all those who have ripping to do, the machine here represented will, without doubt, prove of considerable interest. It is claimed that it will surpass in quality and amount of work any other of this class they may now be using. It is original in every respect and has just been built, and is powerful in all parts. The makers were the first to introduce a machine of this character, and since being placed on the market it has proved a revelation to all those who have used it.

It is designed especially for heavy work, and is particularly recommended to the car builder and other wood workers who have stock that requires heavy framing.

It is safe to operate, a very small kerf is removed, wide or thick material is easily ripped, little power is required, the work is always accomplished easily and rapidly, the table is always at standard height, and the rolls are close together, thus allowing short pieces to be fed. The adjustment of fences and rolls is quickly made, and there is a great saving in time each day in making all the various adjustments. It is admiraby adapted to reducing large timbers to smaller dimensions, ripping wide lumber into strips of varying widths, re-sawing from the side of a timber, and other light work.

The straining device, which controls the upper wheel and the path of the saw blade on the face of the wheels, is new and very sensitive, and is covered by letters patent. No matter what the vibrations are, the strain takes up the slack in the blade instantly, thus adding wonderfully to the perfect working of the machine, and lengthening the life of the saw blades.

The lower wheel is solid, lessening the circulation of dust and air, and giving it-



J. A. FAY & EGAN BAND RIP SAW.

self increased momentum, so that its speed governs the upper wheel and prevents it from overruning the lower.

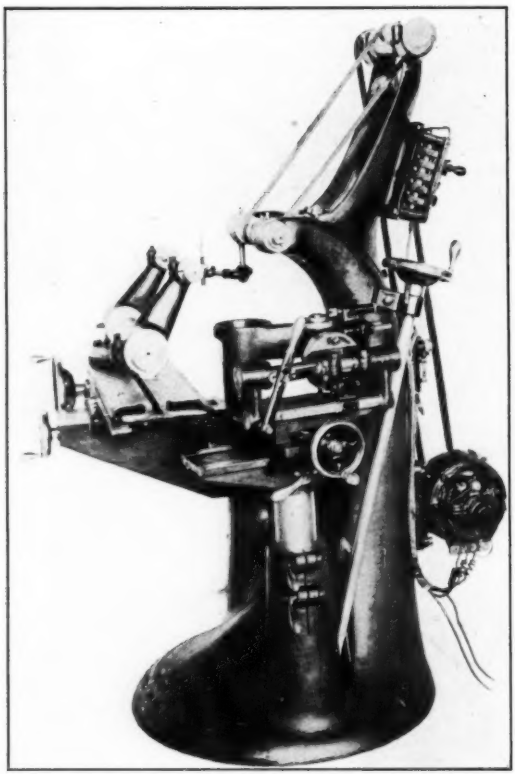
The machine has three feeds and powerfully driven feed rolls in the table and above the table. By a single movement of a lever convenient to the operator, the machine can be instantly changed to a hand feed rip saw, or the feed can be stopped instantly.

Further particulars may be obtained from the makers, J. A. Fay & Egan Co., of No. 212 to No. 232 West Front Street, Cincinnati, who will also send their catalogue of wood working machinery free to those desiring it.

Cutter and Reamer Grinder.

THIS cutter and reamer grinder is designed especially for grinding heavy cutters of large diameter and long face, which are used on the large column and planer-type milling machines, and also the large-diameter inserted-tooth cutters.

It is unlike other cutter grinders in that it requires no extra fixtures for handling any style of milling cutter or reamer, and it will take care of all styles and sizes of cutters, including plain, straddle, form and end mills.



BECKER-BRAINARD CUTTER AND REAMER GRINDER.

The machine has two separate knees, each provided with its own slides, and the cutter to be ground is transferred from one to the other for the different operations on the side and end teeth. This grinder, which is made especially stiff and heavy to eliminate vibration, is provided with two columns, one of which has a knee, with saddle and table, which has 6 inches of vertical adjustment, and will swivel around the column in either direction. The adjustable vertical column is graduated so that the setting can be instantly made to give the proper angle of clearance of the cutter for different diameters of emery wheels used.

The table on the saddle is fed by rack and pinion, having a longitudinal feed of 20 inches and a cross feed of 7 inches, and is provided with a graduated swivel head which carries a bar on which to slide cutters while they are ground. Head and tail centers are also provided for holding end mills and reamers which have to be ground on centers.

With the cutter grinders usually made, it is necessary in order to grind side, face and angular mills, to use special fixtures which consume more or less time in setting, whereas with the machine described, this waste of time is eliminated, as a second column is provided with a swivel carriage carrying two cross slides, the top cross slide having 7 inches and lower slide 9 inches adjustment, at right angles. On the top slide is mounted a graduated swivel head or holder, which slides on a bar, having a travel of 5 inches, and is used for grinding the end teeth of cutters and end mills.

The spindle is made of crucible steel and runs in self-centering boxes provided with wheel mounts fitted with taper end to always insure perfectly true running wheels.

This machine may be run with belt and pulley, or it may be provided with electric-motor drive, as shown in the illustration, and further information concerning either style, as well as of their other machines, will be gladly given by the manufacturers, the Becker-Brainard Milling Machine Co., of Hyde Park, Mass.

The "Loco" Grease and Oil Separator.

AS the strictest economy in the operation of steam plants is daily becoming more necessary, there is a large field for a device which will entirely remove grease and oil from exhaust steam so as to make the latter available for many purposes where

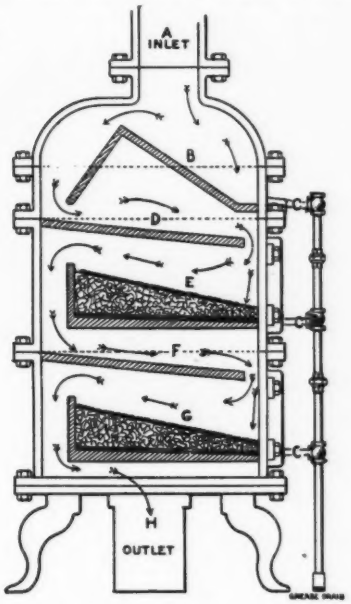
"LOCO" GREASE AND OIL SEPARATOR.

live steam would otherwise have to be employed.

When exhaust steam is used for heating, if it contains even a small percentage of grease and oil the steam condensate adheres to the pipes and forms a non-conducting coating, thus requiring a wasteful quantity of steam to generate the necessary heat. When, owing to imperfect separation, grease and oil get into a boiler, small globules of these materials adhere to its inner surface and prevent the water from touching these places. In consequence, parts of the metal are unprotected and exposed to intense heat which may ultimately cause the shell to buckle, the tubes to pit, and the boiler to become useless, even if it does not explode. At the very best, a boiler with an inner coating of oil is an expensive steam producer.

These and other similar troubles may be done away with by the use of the "Loco" separator, which will entirely remove grease and oil from exhaust steam. As shown in the accompanying illustrations, this separator is of simple and efficient construction. It is made in sections, so that it can be enlarged with the growth of the plant. Each section has a drawer containing fibrous material, which absorbs the grease and oil, the latter draining to a drip pipe, and the purified steam goes on to the outlet.

Every part is easily accessible and the fibrous material may be renewed whenever desirable. This separator, by providing for the removal of the oil as fast as it is col-



SECTIONAL VIEW OF "LOCO" GREASE AND OIL SEPARATOR.

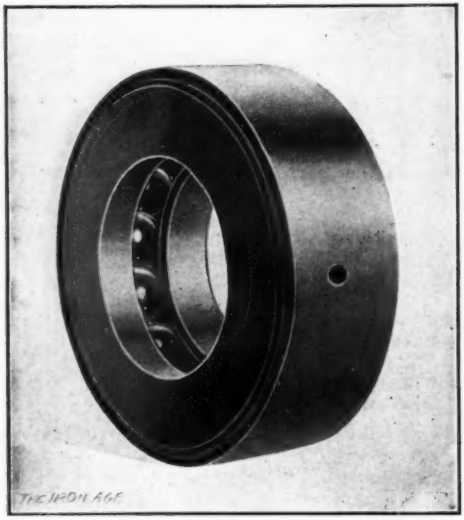
lected, prevents it from again entering the steam line, and the ample dimensions of the passage ways avoid any back pressure on the engine.

Further particulars regarding this separator, which is manufactured under the Rudolph Allert patents, will be gladly given by the Loew Supply & Mfg. Co., of Cleveland.

Reid Ball Bearings.

IT is of the greatest importance for the successful operation of ball bearings that their working parts, especially the balls and the ball raceways, be constructed of the best material, and that the balls themselves be carefully selected to suit the service for which they are intended.

In order to meet these requirements in the most satisfactory manner, it is of great advantage for the manufacturer of ball bearings to make the balls also, and this is done by the American Ball Co., which manufactures the Reid ball bearings. The balls and ball races of these bearings are made of a special high-grade tool steel which combines toughness with hardness. The bearings are manufactured upon the interchangeable system, and duplicate parts can be furnished at short notice.



REID THRUST BEARING. STYLE NO. 1.

In the Reid standard thrust bearing, style No. 1, the sleeve is made of a low carbon steel, not hardened, and is driven tight over the lower thrust plate. The upper thrust plate is made a free running fit in this sleeve, and is held in place by a flange on its upper edge, thus making a self contained bearing.

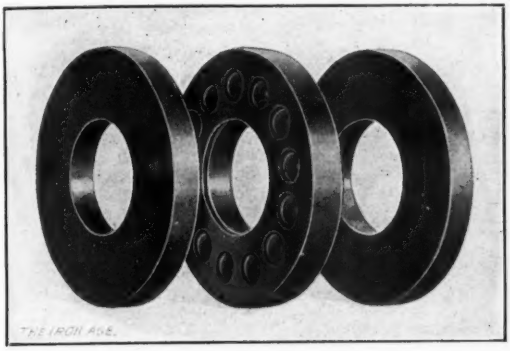
The aim in this design was to construct a bearing in which there should be only rolling contact between the balls and the ball raceways. The two points of contact on the lower plate are in such a position in relation to the axis of the shaft, that the rolling-contact circles on the balls both have the same proportion to the contact circles on the same plate. The point of contact on the upper thrust plate is in a plane parallel to a line drawn through the two points of contact on the lower plate, so that no sliding can take place between the balls and raceways, and the load on the two points of contact must be equal. The tendency to force the balls outward on account of the difference in the angles of contact on the lower plate, is counteracted by the angle on the face of the upper plate forcing them in the opposite direction.

In style No. 2 of the thrust bearing the cage is of original construction, made of machine steel, and though light is unusually strong and durable. Owing to its form and construction, the balls are as close together as if there were no cage. It consists of two parts, an outer and an inner cap, which are pressed together after the balls are placed between them. It is impossible for the balls to drop out, or for the cage to come apart in use, though it can be easily and simply taken apart when necessary. The plates are made of tool steel, hardened, and accurately ground on both sides, and can be reversed in case of wear, making the bearing as good as new.

A large majority of the bearings used are radial bearings, and to meet the various requirements in this field the one shown in the sectional view was designed. It is of novel construction, very compact, self contained and capable of easy adjustment for wear.

The nut lock by which means for adjustment is provided, is one of the main features of the bearing, and is composed of an extended sleeve support formed with screw threads of opposite pitch, and co-acting nuts, both of which are resilient in an axial direction at their contact portions. The inner face of the inner nut is presented rigidly to the adjustable cone, and the op-

posite face of the inner nut is formed in the shape of a marginal resilient flange. Between this flange and the engaging portions of the outer nut is contained a locking washer having flexible teeth adapted to



REID THRUST BEARING. STYLE NO. 2.

co-act with the notched portions of the two nuts. The outer nut is also resilient in an axial direction on account of the web portion between the outer contact portions and the inner threaded part not coming in contact with the inner nut.

A ball-separating ring or cage is generally used, but is omitted where the conditions do not require one. The outside ring, shaft sleeve and adjusting cone are made of tool steel, hardened and ground, the locking nuts and ball-separating rings are made of machine steel, the former being case hardened, and the locking washers are made of a very soft, low-carbon, sheet steel.

REID RADIAL BEARING.

Besides those described, there are other styles of Reid standard ball bearings, and where standard bearings cannot be applied, special ones will be furnished, information about which may be had from the American Ball Co., Providence R. I.

Hamilton-Corliss Vertical Engine.

A NEW vertical cross-compound Corliss engine, patterned on the most up-to-date lines and constructed in the most thorough manner, has recently been brought out by The Hooven, Owens, Rentschler Company.

The bed plate is of the box-section type, deep, massive and strongly webbed, with liberal bearing surface on the foundation. It is cast in one piece and is carried around the crank at full height, forming a deep crank pit to retain oil. This base has easy lines and well rounded corners. The main bearing portion is bored and faced to receive the bottom box, which is of shell type so arranged that it can be removed by raising the shaft enough to remove the weight from the box. This box is arranged for water circulation.

The cylinders are made of close-grained charcoal iron as hard as it is practical to machine. The exhaust chambers are separated from the cylinder walls by an air space. The arrangement is such that there is a 2-inch space between the cylinder walls and the lagging for non-conducting covering. The lagging is of sheet steel with bright polished angles. The valves are located in the barrels, to avoid the inconvenience of having to disconnect the valve gear when the heads are removed, but the valves have been placed in such a manner as to reduce the clearance to about the same as if they were in the heads, by bringing the exhaust valves partly within the cylinder walls, although at no time do the valves enter the space swept by the piston, while the piston is allowed to sweep past the ports. The arrangement is different on the steam valve side. The ports on this side are so arranged that the incoming steam strikes the piston squarely on the end, thus preventing any side shock or pound common to the vertical type of engine. Both steam and exhaust valves are double ported and have a very short travel. The valves are cored and made as light as possible, as are also the pistons.

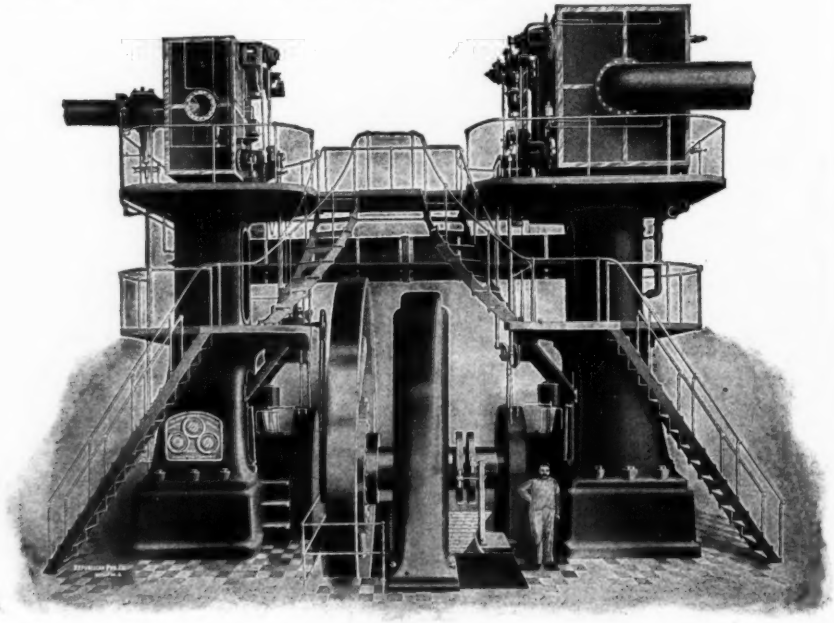
The steam and exhaust valves are ac-

tuated by separate eccentrics, direct, without wrist plates. The necessary motion is obtained by the use of levers and links on each bonnet separately, thus greatly reducing the strains. The dash pots, of a new noiseless pattern, are hung from the bonnets and are close to the cylinder, which makes a very compact and self-contained arrangement. Both steam and exhaust cam rods have efficient unhooking devices so that the valve gear can be worked by hand to facilitate starting and warming up. The valves are double ported with very short travel, and hence receive very little wear.

The governor is of the high-speed, center-weighted, flyball type with motor and micrometer attachment for changing the speed from the switchboard to regulate for throwing electric generators in parallel. It is placed on the first gallery platform and is easily accessible. Both cylinders are under control of the governor, and hence the work is properly divided to suit the load. The range of cut-off is from zero to three-quarter stroke.

The main bearings are lubricated by a continuous stream of oil, which is furnished by an oil pump driven from the eccentric. The oil is pumped from a tank, which is located beneath the floor, to two receivers, which are located over each main bearing cap. From here it flows by gravity to all parts of the journal.

The arrangement of stairways, galleries and platforms is such as to make all parts of the engine accessible, and they are nicely set off with brass hand railing and polished stanchions.



HAMILTON-CORLISS VERTICAL ENGINE.

The engine shown in the illustration has a normal rating of 2,500 horse power and is adapted for direct connection to a 1,500-kilowatt alternator.

These engines are made in all sizes from 16 and 32 by 36 inches to 48 and 96 by 60 inches, and will be constructed for all medium speeds and any desired steam pressure, and arranged for belting or direct connection.

Further particulars may be obtained from the manufacturers, The Hooven, Owens, Rentschler Co., of Hamilton, Ohio.

NEWS SUPPLEMENT

The Engineering Magazine—August, 1904

Coming Society Meetings.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Next meeting, Oct. 4-6, at St. Louis.

AMERICAN ELECTROCHEMICAL SOCIETY. Sec.: S. S. Stadler, 39 S. 10th St., Philadelphia. Next meeting, Sept. 12-17, at St. Louis.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Joint convention with Institution of Electrical Engineers, Sept. 14-17, St. Louis.

AMERICAN INSTITUTE OF MINING ENGINEERS. Sec.: R. W. Raymond, 99 John St., New York. Annual convention, Sept. 14-21, at Duluth, Minn., and Houghton, Mich.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Tuesdays of each month, from October to May, inclusive.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, Oct. 26, at Philadelphia.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION. Sec.: Walter Mower, Detroit. Annual meeting, Oct. 10-15, at St. Louis.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Sec.: Geo. W. Tillson, Municipal Building, Brooklyn, N. Y. Annual meeting, Oct. 4, at St. Louis.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Oct. 10-15, at St. Louis.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Sec.: W. S. Barstow, New York and Portland, Ore. Next meeting, Aug 30-Sept. 1., New Castle, N. H.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Patterson, Concord, N. H. Annual convention, Oct. 18-20, at Chicago.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Meetings on different Thursdays, from October to May.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Sec.: E. W. Poole, Bridgeport. Annual meeting in November.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block. Convention at St. Louis.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September, and on first and third Saturdays from October to March, inclusive.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

INDEPENDENT TELEPHONE ASSOCIATION OF THE UNITED STATES OF AMERICA. Sec.: Frank G. Jones, 48 W. Jackson Boulevard, Chicago. Next meeting, Sept., at St. Louis.

INDIANA PUBLIC UTILITIES ASSOCIATION. Sec.: A. M. Barron, South Bend, Ind. Next meeting, Oct. 18, at Indianapolis.

INSTITUTION OF ELECTRICAL ENGINEERS. Sec.: G. C. Lloyd, 92 Victoria St., Westminster, London. Joint convention with Am. Inst. of Elect. Engrs., Sept. 12-17, at St. Louis.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, Sept. 13-14, at St. Louis.

INTERNATIONAL ELECTRICAL CONGRESS. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12-17, at St. Louis.

INTERNATIONAL ENGINEERING CONGRESS. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting, Oct. 3-8, at St. Louis.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines. Iowa. Regular meetings on third Tuesday of each month.

IRON AND STEEL INSTITUTE. Sec.: B. H. Brough, 28 Victoria St., London, S. W. Annual meeting, Oct. 24-26, at New York.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Sec.: Charles S. Clark, 70 Kilby St., Boston. Meetings second Wednesday of each month, except July and August.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Sec.: W. H. Morton, Utica, N. Y. Annual convention, Sept. 14-16, at St. Louis.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Meeting, Sept., at St. Louis.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW ENGLAND STREET RAILWAY CLUB. Sec.: J. H. Neal, 101 Milk St., Boston. Meetings on last Thursday of each month.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly. at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Oct. 11 and 12, at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Sept., at St. Louis.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minenapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

OHIO ELECTRIC LIGHT ASSOCIATION. Sec.: D. L. Gaskill, Greenville. Next meeting, Aug. 16-18, at Sandusky.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Sec.: Corwin J. Miller, Canton. Next meeting, Nov. 18, at Canton.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesdays of January, March, May, Sept. and Nov. Next meeting, Sept. 13, at Chicago. Annual meeting, Oct. 11, at St. Louis.

RAILWAY WATER SUPPLY ASSOCIATION. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter at Alexander Hall, South Minneapolis, Minn.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE-OF-WAY ASSOCIATION. Sec.: C. E. Jones, Beardstown, Ill. Annual meeting, Sept. 13-15, at St. Louis.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, except June, July and August, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, Sept. 1-3, at St. Louis.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 13, at Chicago.

VERMONT ELECTRICAL ASSOCIATION. Sec.: C. C. Wells, Middlebury. Next meeting, Sept. 21 and 22, at Montpelier.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Dr. Edward Weston, the electrical engineer and inventor, and president of the Weston Electrical Instrument Co., had the degree of Doctor of Science conferred upon him by Stevens Institute of Technology, at its Commencement exercises in June.

—Mr. Gardner S. Williams, M. Am. Soc. C. E. and Professor of Experimental Hydraulics in charge of the Hydraulic Laboratory of Cornell University, has been appointed to the chair in engineering at the University of Michigan, made vacant by the death last fall of Prof. Chas. E. Greene, M. Am. Soc. C. E. This appointment indicates a development of work in the Michigan engineering course along hydraulic and sanitary lines for which, in connection with the laboratories in the new Engineering Building, there are afforded excellent opportunities

—Dr. Schuyler Skaats Wheeler, president of the Crocker-Wheeler Company, sailed recently for England, where he has planned a coaching trip, but as he went on an automobile tour through the south of France early this spring, and returned with the American patent rights of the world-renowned electrical firm of Brown. Boveri & Cie., of Baden, Switzerland, his holiday trips attract a great deal of attention in the electrical business world.

—Mr. Louis Terven, E. E. (University of Wisconsin), has recently been appointed chief electrician of the Nernst Lamp Company, Pittsburg, Pa. Mr. Terven was for some time electrician of the United States Navy Yard, Port Royal, S. C., which position he resigned to enter the experimental laboratory of the Nernst Lamp Company.

—Mr. Fred Harris has severed his connection with the Rand Drill Company, of which he was formerly sales agent in Butte and Salt Lake City.

—Mr. A. L. Waterbury, who was at one time first vice-president and general manager of the Citizens Telephone Co., of Houston, Tex., has accepted a position as general manager of the sales department of the American Conduit Co. Mr. Waterbury will have his headquarters at the Chicago office of this company, 1005-6 Manhattan Building.

—Mr. Walter H. Whiteside, formerly manager of the detail and supply department of the Westinghouse Electric & Manufacturing Company, and, at the same time, general manager of the Sawyer-Man Electric Co., has been appointed general manager of sales for all departments of the Allis-Chalmers Co., including, of course, the Bullock Electric Manufacturing Co., which has become the electrical department of the Allis-Chalmers Co.

Industrial Notes.

The Crocker-Wheeler Company, of Ampere, N. J., by arrangement with the celebrated electrical engineers, Brown, Boveri & Cie., of Baden, Switzerland, have secured their alternating-current designs, patents and rights to manufacture in America, and have retained them as consulting engineers. The Crocker-Wheeler Company are now putting on the market alternating current generators, transformers and accessories of the most perfect design and construction, adapted to American practice, and have already closed a contract for a 200-K. W., 60-cycle, 440-volt, alternating-current generator, for the Atlanta plant of the Proctor & Gamble Co., Cincinnati, and are figuring on an actively increasing number of alternating propositions.

The Grand Trunk Railway System have included in the large list of summer and winter resorts which they are bringing before the public, the sanitarium at St. Catharines, Ont., a retreat for rest and recuperation. A mineral spring from which the water flows and which is used for bathing and massage purposes at this establishment, was discovered years ago, and has been the means of attracting hundreds of the best class of people from the south to enjoy the benefits derived from bathing in it. It is only during the last few years that a commodious sanitarium has been established at this point. combining rest-cure and family hotel. Copies of a neat little booklet giving further particulars may be had by applying to G. T. Bell, general passenger and ticket agent, Grand Trunk Railway System, Montreal, Quebec.

The American Institute of Electrical Engineers has extended an invitation to the Institution of Electrical Engineers of Great Britain to visit the United States in September and to hold a joint meeting in St. Louis in connection with the International Electrical Congress. This invitation has been accepted by the Institution of Electrical Engineers, and a large number of its members, many accompanied by ladies. are expected to arrive in this country by the White Star steamship "Republic" reaching Boston, September 2d. A general invitation has also been extended to European electrical engineering societies to join in a circular tour, visiting principal cities and important industrial centres, organized by the American Institute of Electrical Engineers for the reception and entertainment of its guests and visiting electrical engineers. A number of acceptances have already been received from European electrical engineers and a large delegation of the Associazione Elettrotecnica Italiana, with a number of ladies, is expected to arrive in New York, August 24th and the subsequent days up to September 2d, when they will proceed to Boston, joining the main party there on September 3d. A General Reception Committee and a Committee on Transportation and Arrangements have been appointed by the President of the American Institute of Electrical Engineers and Local Reception Committees have been appointed in the cities which are included in the itinerary of the special circular tour, which will comprise Boston, New York, Schenectady, Montreal, Niagara Falls, Chicago, St. Louis, Pittsburg, Washington and Philadelphia. The Chairman of the General Reception Committee is Mr. J. W. Lieb, Jr., 55 Duane St., New York, and the Chairman of the Committee on Transportation and Arrangements is Mr. E. H. Mullin, 44 Broad St., New York. Foreign electrical engineering societies who may take part in the tour represented by a delegation of their membership, and foreign electrical engineers who desire to accompany the party, are requested to make application at once, giving their names, address and the electrical engineering society with which they are affiliated and from whom they come accredited, and to state when they expect to arrive in the United States, and at what port, to Mr. Ralph W. Pope, Secretary, American Institute of Electrical Engineers, 95 Liberty St., New York City, to whom all communications respecting the circular tour should be addressed. To him also should be addressed all letters, telegrams, etc., for those participating in the tour and while they are en route, and his office will forward them to the nearest stopping place.

—The Allis-Chalmers Company have a power exhibit in the center of Machinery Hall at the St. Louis World's Fair, which includes a 5,000 horse-power Allis-Chalmers engine and Bullock electric generator supplying current for the decorative lighting of the buildings and grounds. At this exhibit visitors will find not only a com-

fortable resting place, but also writing tables and stationery, attendants who will receive and forward mail and telegrams, who will check parcels and wraps and who will provide ice water, all free of charge. Machinery Hall is open until eleven o'clock in the evening.

Dodge & Day, Modernizing Engineers, Philadelphia, in conjunction with Ballinger & Perrot, Architects, are proceeding with the work of re-building and extending the plant of the Victor Talking Machine Company, Camden, N. J. The shops are to be electrically operated and motor drives used throughout. The work is to be completed within six months from date. This is the same concern that suffered a severe damage by fire a short time since.

Arthur Koppel, the manufacturer of narrow and standard gauge railway materials, of 66-68 Broad St., New York, has an exhibition of track switches, turntables, cars of various styles, etc., in the building of Mining and Metallurgy, Block 20, Assignment 10, at the St. Louis Exposition.

The Iron and Steel Institute of Great Britain, of which Mr. Andrew Carnegie is President, will hold its annual meeting in New York on October 24th, 25th and 26th. After this meeting the members of the Institute and their friends will visit Philadelphia, Washington, Pittsburg, Cleveland, Buffalo and Niagara Falls, and those who desire to do so will extend their trip to St. Louis, for the Exposition, returning to New York in time for the steamer sailing Nov. 12th. For the reception of the Institute an influential committee has been formed in the United States, Mr. John Fritz being the President; Mr. Charles Kirchhof, Chairman of the Executive Committee; Mr. Robert E. Jennings, Treasurer, and Mr. Theodore Dwight, 99 John St., New York, Secretary.

The Pittsburgh Gage & Supply Co., of Pittsburg, has installed continuous oiling systems using the White Star Oil Filter at the Carnegie Steel Co., Homestead, Pa.; the Nashville Railway & Lighting Co., Nashville, Tenn.; the Allegheny City Lighting Station, Allegheny, Pa.; the Henry Phipps Power Plant, Pittsburg, Pa., and the Harris Steam Engine Co., Providence, R. I.

The conference committee representing the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Institute of Electrical Engineers and the Engineers' Club, which is administering Mr. Carnegie's gift of $1,500,000 for the erection of the United Engineering Building and the house of the Engineers' Club, has selected the architects for these structures. It was the expressed wish of Mr. Carnegie that the competition should be a mixed one, so that in addition to selecting six competent architects, the committee threw the work open to all comers and provided a prize scheme to compensate the best competitors in the open class. The committee received 26 complete sets of competitive plans for the two buildings, comprising over 500 drawings, and, with the assistance of Prof. W. R. Ware as expert adviser, has spent a good deal of time in the consideration of these designs, all of which, of course, were submitted anonymously. The conclusions now reached are unanimous. The successful competitor for the United Engineering Building is Mr. Herbert D. Hale, of Boston, a competitor in the open class, with Mr. Henry G. Morse, of New York, as associate architect. Mr. Hale is a grandson of Edward Everett Hale and has done a large amount of public architecture in New England and has constructed some Carnegie libraries, besides doing a very considerable amount of work for the New York Shipbuilding Company. The successful competitors for the Engineers' Club are Whitfield & King, of New York, who were among the selected architects; they have done a large amount of work in New York City and on various Carnegie libraries, and were also associated in work on the buildings of the Pan-American Exposition. The designs of this firm were also among those favorably considered for the United Engineering Building, awarded to Mr. Hale. The successful competitors in the open class for four equal prizes of $400 each, in addition to Mr. Hale, are: Trowbridge & Livingston, of New York; Frank C. Roberts & Co., with Edgar V. Seeler, Philadelphia, associate; and Allen & Collins, of Boston. It is interesting to note that a very large proportion of the competitive designs came from Boston and that the largest prize, namely, the award for the United Engineering Building, as well as one of the smaller money prizes, has gone to

that city. As has already been told, the two buildings will require for construction from $1,100,000 to $1,200,000. The United Engineering Building will occupy land 125 feet front by 100 feet on West 39th St., while the Engineers' Club building, with a frontage of 50 feet and a depth of 100 feet, will face on Bryant Park and the new Public Library. The United Engineering Building, aside from quarters for the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers, as well as other societies enabled to participate in the accommodations, will have several fine auditoriums and a magnificent library. The Club building will be about 11½ stories high, with the usual accommodations of a club and some 60 or 70 bedrooms for members. The work of tearing down the old buildings and the construction of the new is to be pushed vigorously and will begin forthwith.

—C. A. Hammel, of Los Angeles, Cal., the patentee and manufacturer of the Hammel oil burner, has published the results of some tests made with these burners on locomotives in regular service on the San Pedro, Los Angeles and Salt Lake Railroad, which were very satisfactory.

—The Bullock Electric Mfg. Co., have removed their New York offices to the Empire Building, 71 Broadway, with E. W. Goldschmidt, the district manager, in charge.

—The Shepherd Engineering Co., of Franklin, Pa., the designers and builders of Shepherd steam engines, have established branch offices, in Chicago, Philadelphia and Boston. The Philadelphia office is in the Witherspoon Building, with Mr. Edward D. Sidman in charge, and the Boston office is situated in the new Oliver Building at Oliver and Milk Streets, in charge of Mr. W. N. Clifford.

—The National-Acme Manufacturing Company, of Cleveland, Ohio, announce the opening of their New York office, R. A. Scranton, manager, in the St. Paul Building, 220 Broadway, where they will be pleased to receive inquiries and orders for "Acme Automatic" multiple-spindle screw machines, "Acme Screw Slotters," semi-automatic, cap screws, set screws, special screws, and parts milled from rod or bar.

—The Niagara Machine & Tool Works, of Buffalo, N. Y., the manufacturers of tools for sheet metals, have an interesting exhibit in the Machinery Building, at the World's Fair, St. Louis, including automatic can machinery, presses, shears, tinners' tools, and other machines.

—The International Electrical Congress will convene at St. Louis, beginning at 9:30 A. M., on Monday, September 12, 1904. The opening ceremonies of the Congress will be held in the Music Hall of the Coliseum, at Olive and Thirteenth streets. The meetings of the eight sections will follow commencing at 11 A. M., in the section halls on the second floor of the Coliseum, the sections adjourning on Monday, at 1:30 P. M. On Tuesday, Thursday and Friday the sections will meet on the second floor of the Coliseum at 9 A. M., and will adjourn not later than 1 P. M. On Wednesday at 10 A. M., the Annual Convention of the American Institute of Electrical Engineers will be formally opened at Festival Hall in the grounds of the Louisiana Purchase Exposition, and the President of the Institute, Mr. Bion J. Arnold, will then deliver the annual address. Immediately afterward a topical discussion will follow between the Institution of Electrical Engineers of Great Britain and the American Institute of Electrical Engineers, the subject of which will be announced later. Arrangements are being made for holding a closing meeting of the International Congress and this will probably be held in one of the buildings in the grounds of the Exposition. The International Electrical Congress is held under the auspices of the Louisiana Purchase Exposition and the following bodies in America are co-operating in the holding of the Congress: The American Institute of Electrical Engineers, The American Electrochemical Society, American Physical Society, The National Electric Light Association, The Association of Edison Illuminating Companies, International Association of Municipal Electricians, The American Electro-Therapeutic Association. The fee for membership in the Congress is $5, which may be forwarded to either the Secretary, Dr. A. E. Kennelly, Harvard University, Cambridge, Mass., or the Treasurer, Mr. W. D. Weaver, 114 Liberty St., New York.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Boilers.

Pamphlet, containing illustrations and descriptions of the McNaull patent economic safety water-tube boilers, in both horizontal and vertical types, and for both stationary and marine use, with views of many buildings and plants where they are installed. Also, table giving heights of chimneys and commercial horse power of boilers. 6 by 9 in.; pp. 48. W. D. McNaull, Toledo, O.

Cement.

Pamphlet, entitled "The Cement Age: The Many Uses and Increasing Demand for Plastic Materials," by R. W. Lesley, a reprint of a paper before the Engineers' Club of Philadelphia. 9 by 6 in.; pp. 8. American Cement Co., 22 S. 15th St., Philadelphia.

Centrifugal Pumps.

Pamphlet, with diagrams and description of the Brooks centrifugal pump, showing the reasons for its high efficiency. 9 by 6 in.; pp. 8. Wm. H. Cook & Co., Monadnock Building, Chicago.

Coal Pockets.

Booklet No. 38, 1904, with illustrations and descriptions of retail coal pockets and coal storage plants, and of coal handling machinery. 9 by 6 in.; pp. 32. The Link-Belt Engineering Company, Nicetown, Philadelphia.

Condenser.

Folder, illustrating and describing a saturating air surface condenser which condenses, at atmospheric pressure, the exhaust steam from the engines and other apparatus in the artificial ice plant of the Vanderslice-Lynds Mercantile Co., of Kansas City. 13½ by 5¾ in.; pp. 4. Atmospheric Condensation Co., Kansas City, Mo.

Crushing Machinery.

Catalogue, containing testimonials from users of Williams' crushing, pulverizing, granulating, shredding and grinding machinery, with illustrations of a few of these machines. 9 by 6 in.; pp. 120. The Williams Patent Crusher and Pulverizer Co., St. Louis.

Drills.

Catalogue, containing illustrations and descriptions and prices of rope-driven and electric portable drills, duplex and five-spindle boiler-shell drills, hand drills, and auxiliary appliances. 9 by 6 in.; pp. 44. Thos. H. Dallett Co., York St. and Sedgley Ave., Philadelphia.

Drop Forgings.

Catalogue, containing illustrations and descriptions of improved drop hammers, die shocs, with two die keys, automatic trips, drop boards, board guards, concrete foundations, trimming presses, heating furnaces, Lombard's patent lifting jacks, and other details of drop hammers, and appliances for making drop forgings. 10¾ by 7 in.; pp. 36. The Billings & Spencer Company, Hartford, Conn.

Electric Apparatus.

Several publications, including pamphlets on electric fan motors, lightning arresters, and the Curtis steam turbine; bulletins on cable-testing current transformers, sewing-machine motors and pocket instruments for direct or alternating current; and flyers, booklets and price lists devoted to various kinds of electric instruments and apparatus. General Electric Company, Schenectady, N. Y.

Electric Drill.

Special circular No. 48, illustrating and describing the Duntley air-cooled electric drill, fitted with feed screw and breast plate, and with a switch in the handle, made in various sizes and adapted to a great variety of work. 11 by 8½ in.; pp. 2. Chicago Pneumatic Tool Co., Fisher Building, Chicago.

Electric Generators.

Bulletin No. 47, entitled "The Power of the Intramural," containing illustrations and descriptions of the electric generating plant of the Intramural," containing illustrations and de-Fair, with a map of the exposition grounds. 10 by 7½ in.; pp. 12. Crocker-Wheeler Company, Ampère, N. J.

Electric Locomotives.

Bulletin No. 8, entitled "Electric Locomotives for Gathering Purposes," by C. E. Waxborn, containing descriptions and illustrations of types of these locomotives for use in coal mines. 10 by 8 in.; pp. 16. The Jeffrey Manufacturing Co., Columbus, O.

Fireproof Windows.

Folder, calling attention to the Lupton fireproof window, of original design and superior hollow sheet steel or copper construction, and glazed with wire glass. 12½ by 10 in.; pp. 2. David Lupton's Sons Company, Allegheny Ave., and Tulip St., Philadelphia.

Furnaces.

Catalogue, containing illustrations and descriptions of Stewart gas furnaces which burn any kind of gas and are adapted to a great variety of purposes, and also of flexible shafts, with some of their numerous applications. 7¾ by 10¾ in.; pp. 64. The Chicago Flexible Shaft Co., La Salle Ave. and Ontario St., Chicago.

Gas Producers.

Pamphlet, describing and illustrating a suction gas producer, showing its advantages, and comparing gas producer plants with other systems of power generation. 9 by 4 in; pp. 12. Baltimore Gas Machinery Co., Baltimore.

Graphite.

Pamphlets and booklets devoted to graphite in several forms and for various purposes, entitled "Graphite Afloat and Afield," "Graphite as a Lubricant," "Oil vs. Grease Lubrication," "Dixon's Graphite Cup Greases," "Dixon's Ticonderoga Graphite Grease," and "Slipping Belts," the last describing Dixon's traction belt dressing and leather preservative. Joseph Dixon Crucible Co., Jersey City, N. J.

Heaters.

Booklet, giving illustrations, dimensions, ratings and prices of Thatcher steam and hot water heaters, radiators and specialties. 6 by 3½ in.; pp. 24. Also, folder devoted to Thatcher heaters, ranges, and tubular warm air furnaces. 7 by 7 in.; pp. 6. Thatcher Furnace Co., 240 Water Street, New York.

Hobs.

Pamphlet containing a list of stock hobs, the tools for forming the teeth of worm gears, with dimensions and other data. 9¼ by 6 in.; pp. 8. R. D. Nuttall Company, Pittsburg.

Machine Tools.

Lousiana Purchase Exposition special number of the "Progress Reporter" for July, 1904, a pamphlet containing illustrations and descriptions of heavy axle and car wheel lathes, turret lathes, forge planers, milling machines, shaping machines, drills, boring mills, hydraulic riveters, steam hammers, cranes, Pratt & Whitney screw machines, turret lathes and small tools, and other machine tools shown at the St. Louis Fair. 12 by 9 in.; pp. 36. Niles-Bement-Pond Co., 136-138 Liberty St., New York.

Catalogue, containing illustrations, descriptions and prices of turret lathes, square-arbor lathes, valve-milling machines, ball machines, chucks, slide rests, oil separators for removing oil from chips, turnings and cuttings, and other tools and appliances. 6 by 9¼ in.; pp. 33. American Tool & Machine Co., Boston.

Nernst Lamps.

Booklet, entitled "The Value and Utility of the Nernst Lamp in the Central Station," showing the many advantages of this electric lamp for various kinds of lighting, particularly in the field between arc and incandescent lamps. 6 by 3½ in.; pp. 16. The Nernst Lamp Co., Pittsburg.

Pipe.

Folder, describing and illustrating Root spiral riveted pipe, and containing detachable index card and postal card. 7½ by 3½ in.; pp. 8. Also, folder devoted to Root spiral riveted bilge pumps and A. & R. exhaust heads. Abendroth & Root Mfg. Co., Newburgh, N. Y.

Pneulubric.

Folder, describing "Pneulubric," a lubricant for pneumatic tools, which is made in solid and liquid forms, the former being especially adapted to rotary drills, and the latter to hammers, riveters and air compressors. 5¾ by 3½ in.; pp. 6. Philadelphia Pneumatic Tool Co., 21st St. and Allegheny Ave., Philadelphia.

Pneumatic Hammers.

Pamphlet, illustrating and describing Haeseler "axial-valve" pneumatic hammers, for chipping, riveting, and other purposes. 3½ by 8¼ in.; pp. 10. The Ingersoll-Sergeant Drill Co., Pneumatic Tool Department, 26 Cortlandt St., New York.

Pneumatic Tubes.

Book, containing half-tone illustrations and descriptions of pneumatic-tube service as applied to the transportation of mail, messages, merchandise, cash, and other matter, and also of other carrying appliances for banks, factories, stores and libraries. 9¾ by 7 in.; pp. 48. American Pneumatic Service Co., Boston.

Presses.

Catalogue, containing illustrations and descriptions of a great variety of power presses, punches, shears, seamers, beading and flanging machines, plate-bending rolls, and other machines and appliances for sheet metal work. 8 by 5½ in.; pp. 176. Perkins Machine Company, Warren, Mass.

Screws.

Booklet, describing an electric welding method of making finished screws and bolts of iron, steel, brass, bronze, and other metals, and showing illustrations of screws. 6 by 3½ in.; pp. 12. Also folder devoted to finished steel machine bolts. The Cleveland Cap Screw Co., Cleveland, O.

Slotting Machines.

Catalogue No. 38, containing illustrations and descriptions of slotting machines of various kinds and sizes, including armor-plate, gear-cutting, railway-frog, traveling head, portable and other styles, both motor and belt driven. 9 by 6 in.; pp. 24. Newton Machine Tool Works, Inc., Philadelphia.

Steam Traps.

Booklet, entitled "A Short Talk to the Man Behind the Check Book," which describes in an entertaining way the advantages of the Bundy steam trap. 6 by 3½ in.; pp. 12. A. A Griffing Iron Company, Jersey City, N. J.

Thermit.

Folder, devoted to the aluminothermic process for welding of all kinds, repairing castings, reviving iron and steel in castings and ingots and preventing flaws and piping, producing rare metals free from carbon, and for other purposes, with illustrations of a rail-welding outfit and of a welded sternpost of an ocean steamer. 8½ by 3½ in.; pp. 6. Goldschmidt Thermit Co., 43 Exchange Place, New York.

Time Register.

Pamphlet, illustrating and describing the Dey time register, for recording the arrival and departure of employees, with facsimile of the records, list of users and testimonials. 9 by 5 in.; pp. 32. Also, card showing a record as made with a combination red and green ribbon, by which tardiness is detected at a glance. Dey Time Register Co., Syracuse, N. Y.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The "Loco" Grease and Oil Separator.

THE rapid progress in all lines of power generation makes it necessary for steam engineers to pay the strictest attention to all the details of their plans, and to stop waste and leakage of every kind.

The exhaust steam, which in many cases has been allowed to go to waste, is now regarded as offering great possibilities for economy, and if the grease and oil can be removed therefrom, it can be used for many purposes.

An apparatus which, it is said, will entirely remove these impurities from exhaust steam is the "Loco" grease and oil separator. This device is economical and convenient, and is simple and effective in operation, as may be seen from the accompanying illustrations.

"LOCO" GREASE AND OIL SEPARATOR.

In the sectional view on the third page, the steam enters at the flange opening marked A and strikes the solid iron plate B which is placed at an angle of about 40 degrees. The sharp decline of this plate precipitates the condensate grease and oil to the discharge pipe C. The steam then rises and again passes down, striking the baffle plate D. It then filters through the drawer of fibrous material, covered with a coarse wire screen, E.

The condensate grease and oil striking the coarse wire screen is absorbed in the fiber directly underneath, and drips through to the ribbed bottom of the drawer, where it rapidly drains to the drip pipe C, out of reach of the onrushing steam.

The steam then passes to the baffle plate F, after which it reaches the second drawer G, where the process of absorption by the fiber under the netting is repeated. The steam is then discharged through the outlet H.

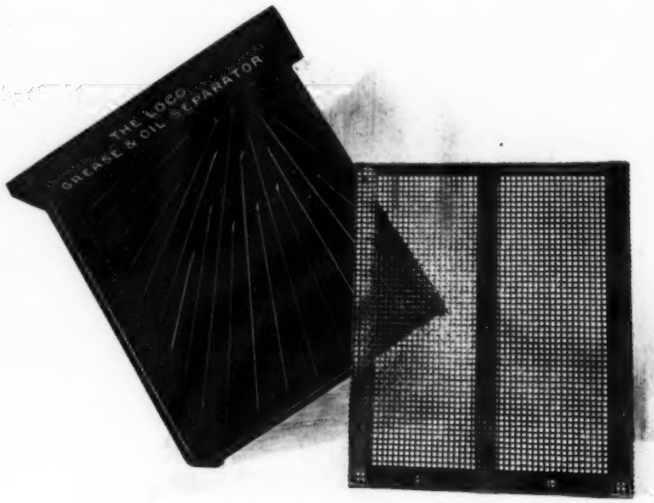
An important advantage of the "Loco" grease and oil separator is, that having bought a single-drawer device, and desiring to increase the capacity of the steam line, the capacity of the separator can be correspondingly increased by simply adding more drawers.

There is nothing at all complicated about this apparatus and every part is easily accessible, and an examination of the sectional view will show that back pressure on the boiler is avoided, as there is ample space to admit of expansion.

In some separators the oil and grease is removed from the steam in small particles and adheres to the iron baffle plates, which admits of its being easily picked up by the onrushing steam current and again carried into the steam line, but the "Loco" separator absolutely avoids this trouble by

filtering the steam through fibrous material, which collects and absorbs all impurities and discharges them to the drain pipes, thereby preventing the accumulation of objectionable deposit.

Whenever desired, the drawers of the "Loco" separator may be repacked by placing a layer of fresh fiber under the screen and re-inserting the drawer in the separator, the whole process of cleaning and renewing taking only five minutes.



DRAWER AND SCREEN COVER FOR FIBROUS MATERIAL OF "LOCO" GREASE AND OIL SEPARATOR.

The illustration on this page shows one of the drawers, with its ribbed bottom, for holding the fibrous material, and the wire screen which covers the latter.

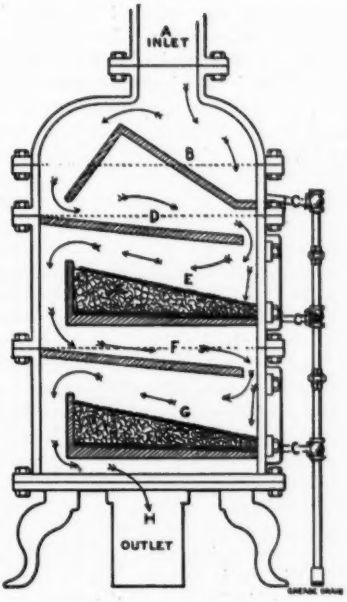
The installation of this separator will largely increase the capacity of a plant by rendering the exhaust steam useful for many purposes where live steam is now required. It will save fuel and labor, and will prove economical in every way.

Further information concerning the "Loco" grease and oil separator, which is manufactured under Rudolph Allert's patents, will be cheerfully furnished by the Loew Supply and Manufacturing Co., of Cleveland.

A Gear Shaper with Motor Drive.

IN the few years that the Fellows gear shaper has been before the public it has achieved wide-spread recognition for its merits, as evidenced most convincingly by the large number now in use. To-day nearly all shops that engage in gear cutting to any extent, have one or more of these machines, so that it is hardly warrantable to enter here into a description of its details, which may be found in the catalogue published by the builders, the Fellows Gear Shaper Company, of Springfield, Vt.

However, it may be said here briefly, that the shaper differs from the other forms of gear-cutting machinery in that it replaces the rotating milling cutter they employ by a reciprocating tool having the form of a spur gear. This planes the teeth and at the same time is caused to revolve with the blank, intermeshing precisely as its finished mate is intended to. In degree of accuracy this scheme compares with the hobbing method of forming worm-wheels, and also corresponds very closely to it in principle. The cutters for both may be produced with extreme precision, as in



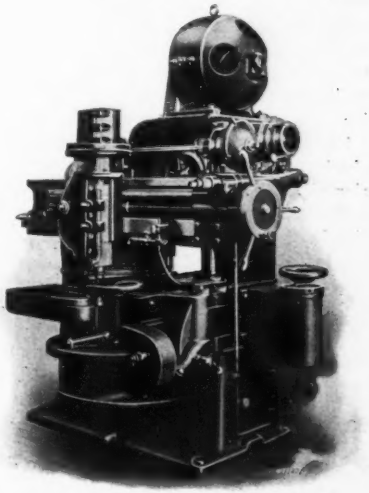
SECTIONAL VIEW OF "LOCO" GREASE AND OIL SEPARATOR.

involute gearing, the only type now in common use, both depend on generation by straight lines. For instance, a hob is cut as a perfect V-thread, and the Fellows cutter is finished by being caused to roll against a beveled emery wheel with a motion simulating that of a pinion tooth against a rack tooth.

It is the present desire to call particular attention to the machine as now provided with individual motor drive. The only special work necessary was the casting of a plate to span the pillow blocks of the regular driving gear to afford a support for the motor, and the substitution of a sprocket wheel for the cone pulley used with belt drive. With these changes a standard form has been evolved as shown in the accompanying illustration.

A 5-horse-power Crocker-Wheeler semi-enclosed type motor supplies the power, transmitting it with a reduction in speed through a Renold silent chain to the spindle which normally holds the cone pulley. The speed is further reduced through either of two regular gear combinations which are used alternately, making two speeds possible mechanically. In addition, the motor is supplied with current on the Crocker-Wheeler four-wire multiple-voltage system, giving it six independent speeds, and with the use of resistance twelve intermediate ones. The upper ten of the motor's eighteen speeds constitute its working range within which, through the faster gear combination, it drives the ram at from 94 to 45 strokes per minute, or, with the slower gear combination, 43 to 20. The lower eight available motor speeds may be used to extend the range down to 6 strokes per minute, though 20 is the minimum in ordinary practice. The machine is capable of cutting external gears up to 36 inches in pitch diameter by 5 inches face, and internal gears 28 inches in pitch diameter by 3 inches face, allowing any diametral pitch up to four.

Any further information which may be desired will be supplied by the Crocker-Wheeler Company, of Ampere, N. J.



FELLOWS GEAR SHAPER DRIVEN BY CROCKER-WHEELER MOTOR.

Bristol's Thermometer-Thermostat.

A NEW instrument has been placed upon the market which has been given the above compound name, since it is a combination thermometer and thermostat. There is a demand for an instrument of this character which will give correct indications of the temperature of the atmosphere, gases or liquids at all times, and

BRISTOL'S THERMOMETER-THERMOSTAT. EXTERNAL VIEW.

also serve as a thermostat to make electric connection at any predetermined limits of temperature for the purpose of operating controlling apparatus, alarms and the like.

In Figure 1 is shown an external view of the instrument, which is provided with a six-inch scale graduated in degrees Fahrenheit, but its construction and capabilities will be best understood by referring to the interior view, Figure 2, where A is an arm pivoted at the lower portion of the case, terminating in a point resting on the arc of the graduated scale, and held by friction at whatever position it may happen to be set. Two adjustable contact pieces, B and C, are carried by this arm. These contact pieces are capable of adjustment by means of a screw D, which is threaded so as to cause the contact pieces B and C to approach or recede at equal rates and distances from the center line of the arm A, upon which they are supported. They are also connected to binding posts, as shown, which are used for making outside connections. These binding posts are located within the case to avoid any possibility of the wires or connections being disturbed without detection. Three holes with insulating eyelets are provided in the lower portion of case, for the insertion of connecting wires. The high and low contacts can be placed on a single circuit or on independent circuits.

The arm E, moving over the graduated scale, indicates the changes of temperature where the instrument is located. This arm is operated by one of Bristol's recording thermometer tubes placed in the perforated protecting projection extending from the back of the case, as shown in the illustration. On the back of the indicating pointer E there is a raised portion which makes electric connection with the contact pieces.

A novel feature of the instrument is that the temperature-indicating arm E is not restrained by the thermometer-thermostat contacts, so that the controlling effect of the thermostat is perfectly adjustable as to position on the scale of the thermometer, and also as to high and low limits of operation, without in any way interfering with the correct indications of the thermometer in case the temperature does not remain, or is not controlled, within the limits for which contact pieces are set.

BRISTOL'S THERMOMETER-THERMOSTAT. INTERIOR VIEW.

The instrument can be readily applied to liquids, and may, for instance, be used to indicate the temperature of, and set into operation controlling apparatus for, the brine in a refrigerating system or tank.

For temperatures above the atmosphere, as those occurring in ovens, kilns, closed spaces, or of liquids in pipes under pres-

sure, a small bulb is located within the closed space or pipe. This bulb is connected with the thermometer-thermostat by a capillary tube filled with alcohol. The temperature at the bulb is communicated to the instrument, which may be located at any convenient point for observation.

The electric wires connecting with the adjustable thermostatic contacts may be carried to any point where the controlling apparatus is located or where it is desired that an alarm shall be given.

From the foregoing description it will be seen that the instrument is very flexible in its application, and it is not improbable that still other applications may suggest themselves. Any further information desired will be gladly supplied by the Bristol Company, of Waterbury, Conn.

Pioneer Transit.

SOME new surveying instruments, the "Pioneer" transits, one of which is shown in the accompanying illustration, have recently been placed upon the market. They are light and portable, especially designed for moderately accurate work, and can be recommended for rapid and preliminary surveying.

The telescope of these instruments is 8½ inches long, and has a one-inch objective, which is provided with a rack-and-pinion movement, dust guard, sunshade and dust cap, while the eye-piece is focused by an improved spiral movement. Attached to the telescope is a 3¼-inch bubble, which is graduated on the glass; the vertical circle is 3½ inches in diameter and graduated to degrees, which one double-folded adjustable vernier subdivides to 5 minutes; fine settings can be obtained by means of the clamp and tangent screws attached to the telescope axis, one of whose bearings is adjustable for height.

The compass box is silvered, and is graduated to degrees on a raised ring. The needle is 3 inches long, and very sensitive, and has a jeweled center. It is balanced for latitude by a small coil of wire, which can be shifted along the southern part of it. The deviation of the needle can be corrected by means of a variation plate, which is operated by a rack movement, and reads to 5 minutes.

On the upper plate are two fine level vials. The horizontal limb is 5 inches in diameter, graduated to ½ degrees, one double vernier reading to single minutes. The inner and outer centers are each provided with clamps and tangent screws, while the instrument is leveled up by means of four leveling screws and has a shifting center.

These transits can also be furnished without a vertical circle or without compass, the latter being introduced under the name of "Architects'" transit.

KOLESCH "PIONEER" TRANSIT.

All of these instruments are of the same material and workmanship as the more expensive instruments of their manufacturers, Messrs. Kolesch & Co., of 138 Fulton St., New York, who will be pleased to furnish any further information that may be desired.

Wagner Cold Saw Cutting-Off Machine.

ONE of the Wagner cold saw cutting-off machines is shown in the accompanying illustration. The saw is mounted on an arbor that is carried in a swivel head secured to the front of the ram, which travels in a long rigid guide. The head is graduated and can be swung clear around in a vertical plane and clamped in any position, thus making it possible to cut off the stock at any desired angle.

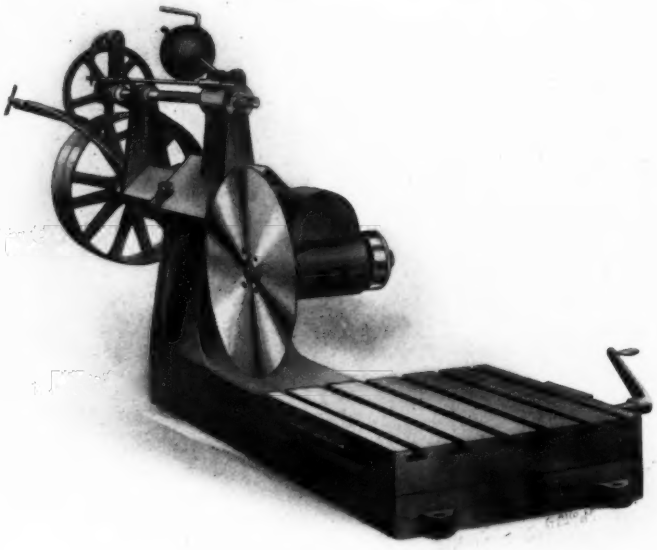
The arbor is driven by means of a phos-

phor-bronze worm wheel and steel worm, the worm shaft running longitudinally through the ram and carrying on its end tight-and-loose driving pulleys, thus requiring no countershaft.

The feed is positive and is obtained by means of an eccentric on the end of the worm shaft. The feed screw is journalled in a bracket at the end of the ram and runs through a nut which fits freely in a bracket cast on the top of the ram guide. The screw is rotated by a ratchet wheel and pawl. A rack is formed at the top of the feed nut, and meshing with this feed rack is a pinion to which is attached an arm carrying an adjustable weight. This arrangement makes a very sensitive feed; it is easily regulated by shifting the weights, and when the saw becomes dull and does not cut freely or the cross-section increases, the weighted arm lifts and releases the feed and prevents the saw breaking or becoming jammed. A pan is formed in the table for soap water or other lubricant in which the saw constantly dips.

The 12-inch saw will cut rounds up to 3½ inches in diameter; the largest machine, carrying a 40-inch blade, will cut rounds up to 13 inches in diameter. These machines are built with seven sizes of saw blades, and as many as four different styles of bed plates and vises with each style of saw blade. A special study has been made of designing different styles to meet the varying requirements to which this unique cold saw cutting-off machine can be put.

The machines for cutting long I-beams, channels or heavy shafts is so designed that it is not necessary to turn the work around when it is desired to cut off both ends.



WAGNER COLD SAW CUTTING-OFF MACHINE.

Another machine is designed for cutting off risers and sink heads from steel castings. In this machine the table is adjustable vertically, and by setting the swivel head so that the saw arbor stands vertical, the difficulty heretofore experienced in setting the casting is overcome, as the casting can be set naturally or in the position in which it was cast with sinkhead vertical.

The Diamond Drill & Machine Company, of Birdsboro, Pa., have secured the right to manufacture these machines in America, and will be glad to supply any further information concerning them.

High-Efficiency Fuel Economizer.

THE two most essential qualities of a fuel economizer are its ability to utilize most efficiently for heating water a maximum amount of heat (otherwise wasted) from the escaping gases, and the accessibility of all surfaces for cleaning, repairing and renewals. The Sturtevant "Standard" and "Pony" type economizers were designed to make possible these two requisites. These economizers utilize practically all the waste heat from the gases by a patent system of staggered pipes. This system compels all the hot gases to encircle the pipes, so increasing the effective heating surface to a maximum. The gases are thus broken up and forced to give up their heat to the surrounding surfaces.

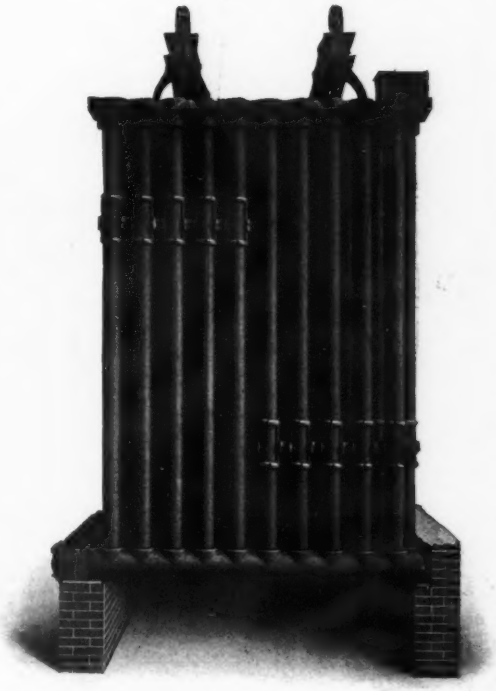
A fuel economizer must be accessible both inside and outside if it is to be a valuable adjunct to a power plant. To make this possible the joints of the Sturtevant economizer are made taper metal to metal, and are so designed that any pipe can be taken out and a duplicate substituted without disturbing any other pipe, section or side walls. This would not be possible if packing, cement or rusting were used to make tight joints.

Any header can be withdrawn and a duplicate substituted without disturbing any other header, section or side walls. Any section can be withdrawn and a duplicate replaced without disturbing any other section or side walls. There are no connection pipes to remove and all water surfaces are rendered accessible by the simple removal of the caps.

The taper metal to metal joints make these economizers especially valuable for high pressures and are a marked improvement over gasket joints, which spring and leak and give trouble under such pressures.

The scrapers are interchangeable and the driving mechanism positive in action. A guide plate for the scrapers is used to insure the scrapers' position, and prevents them from sticking and breaking. The driving pulley can be belted up parallel or perpendicular to the length of the economizer.

The Sturtevant economizers are not designed for forced circulation, but the connections are made in such a way that the flow of water is started in the right direction and tends to keep the flow up and down the consecutive sections without making undue work for the pump.



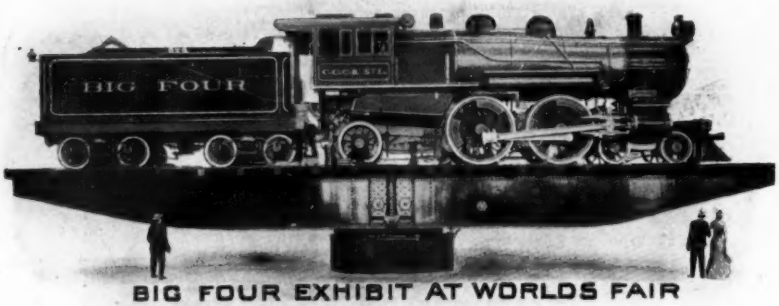
STURTEVANT STANDARD FUEL ECONOMIZER.

Two general types of economizers are made by the B. F. Sturtevant Company, the "Standard" and the "Pony." The "Standard" is built in sections of from four to twelve pipes wide, the staggered system of pipes making it possible to build sections

of an odd as well as of an even number of pipes. The "Standard" economizer is adaptable to power plants of almost any size, but is more commonly used for boiler capacities of 350 horse-power and over.

The "Pony" type, as its name implies, is smaller than the "Standard," and is more adaptable to power plants of 350 horse-power or less.

An illustrated catalogue describing these economizers is issued by the B. F. Sturtevant Co. of Hyde Park, Mass., who will be pleased to furnish any further information that may be desired.



BIG FOUR TURNTABLE AND LOCOMOTIVE.

Locomotive and Turntable Exhibit.

THE exhibit of the "Big Four Route" at the Louisiana Purchase Exposition in many respects marks not only an era in locomotive science, but in the mechanical and electrical arts as well.

While exhibits have been shown of locomotives and turntables in motion, it involved a new proposition to install the Big Four exhibit in the Transportation Building at the World's Fair in St. Louis. The observer cannot see anything which operates the turntable or the locomotive, nor are the wheels blocked on track.

The locomotive shown is one of the type which hauls the Knickerbocker Special, New York and Boston Limited, Cincinnati and Washington Express, and other famous trains of the Big Four Route. The engines maintain a speed of sixty miles per hour, with ten-car trains on the Big Four roadways, and have a speed record of a mile in thirty-nine seconds with a six-car train, equivalent to a speed of ninety-two miles per hour. This record was made in the course of regular business, and undoubtedly, on a test made with preparations in advance, even a better showing could be made.

The locomotive was constructed by the American Locomotive Co. The engine proper weighs 184,000 pounds; the tender, 140,000 pounds, and the total weight in working order, is 324,000 pounds, or 162 tons. The steam pressure is 200 pounds per square inch, the coal capacity of the tender is ten tons, and the water capacity 7,500 gallons. The drivers are seventy-nine inches in diameter. It is interesting to know that 55,000 pounds of sand is in the tender or turntable, to counterbalance the engine and prevent the motion of the drivers from tipping the turntable.

Further particulars regarding the turntable and this exhibit in general will be gladly furnished by The Cleveland, Cincinnati, Chicago & St. Louis Railway Co., the "Big Four Route," Cincinnati.

NEWS SUPPLEMENT

The Engineering Magazine—September, 1904

Coming Society Meetings.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Next meeting, Oct. 4-6, at St. Louis.

AMERICAN GAS LIGHT ASSOCIATION. Sec.: A. E. Forstall, 58 William St., New York. Annual convention, Oct. 19-21, at Washington.

AMERICAN ELECTROCHEMICAL SOCIETY. Sec.: S. S. Stadler, 39 S. 10th St., Philadelphia. Next meeting, Sept. 12-17, at St. Louis.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Joint convention with Institution of Electrical Engineers, Sept. 14-17, St. Louis.

AMERICAN INSTITUTE OF MINING ENGINEERS. Sec.: R. W. Raymond, 99 John St., New York. Annual convention, Sept. 14-21, at Duluth, Minn., and Houghton, Mich.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Tuesdays of each month, from October to May, inclusive.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, Oct. 26, at Philadelphia.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION. Sec.: Walter Mower, Detroit. Annual meeting, Oct. 10-15, at St. Louis.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Sec.: Geo. W. Tillson, Municipal Building, Brooklyn, N. Y. Annual meeting, Oct. 4-6, at St. Louis.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Oct. 10-15, at St. Louis.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Sec.: W. S. Barstow, New York and Portland, Ore. Next meeting Aug. 30-Sept. 1., New Castle, N. H.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Patterson, Concord, N. H. Annual convention, Oct. 18-20, at Chicago.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meeting on second Thursday of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays, from October to May.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Sec.: E. W. Poole, Bridgeport. Annual meeting in November.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block. Convention at St. Louis.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September, and on first and third Saturdays from October to March, inclusive.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesdays of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

INDEPENDENT TELEPHONE ASSOCIATION OF THE UNITED STATES OF AMERICA. Sec.: Frank G. Jones, 48 W. Jackson Boulevard, Chicago. Next meeting, Sept., at St. Louis.

INDIANA PUBLIC UTILITIES ASSOCIATION. Sec.: A. M. Barron, South Bend, Ind. Next meeting, Oct. 18, at Indianapolis.

INSTITUTION OF ELECTRICAL ENGINEERS. Sec.: G. C. Lloyd, 92 Victoria St., Westminster, London. Joint convention with Am. Inst. of Elect. Engrs., Sept. 14-17, at St. Louis.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, Sept. 13-14, at St. Louis.

INTERNATIONAL CONGRESS OF ARTS AND SCIENCE. Sec.: Howard J. Rogers, Universal Exposition, St. Louis. Meeting, Sept. 19-25, at St. Louis.

INTERNATIONAL ELECTRICAL CONGRESS. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12-17, at St. Louis.

INTERNATIONAL ENGINEERING CONGRESS. Sec.: Charles Warren Hunt, 220 W. 57th, St., New York. Meeting, Oct. 3-8, at St. Louis.

INTERNATIONAL RAILWAY CONGRESS. General Sec.: Louis Weissenbruch, Belgian State Railways, Brussels, Belgium. Sec. of American Section: W. F. Allen, 24 Park Place, New York. Seventh session, May 3-15, 1905, at Washington.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

IRON AND STEEL INSTITUTE. Sec.: B. H. Brough, 28 Victoria St., London, S. W. Annual meeting, Oct. 24-26, at New York.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Sec.: Charles S. Clark, 70 Kilby St., Boston. Meetings second Wednesday of each month, except July and August.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Sec.: W. H. Morton, Utica, N. Y. Annual convention, Sept. 14-16, at St. Louis.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Meeting, Sept., at St. Louis.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW ENGLAND STREET RAILWAY CLUB. Sec.: J. H. Neal, 101 Milk St., Boston. Meetings on last Thursday of each month.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Oct. 11 and 12, at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Sept., at St. Louis.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Sec.: Corwin J. Miller, Canton. Next meeting, Nov. 18, at Canton.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Next meeting, Sept. 13, at Chicago. Annual meeting, Oct. 11, at St. Louis.

RAILWAY WATER SUPPLY ASSOCIATION. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter at Alexander Hall, South Minneapolis, Minn.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE-OF-WAY ASSOCIATION. Sec.: C. E. Jones, Beardstown, Ill. Annual meeting, Sept. 13-15, at St. Louis.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, except June, July and August, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, Sept. 1-3, at St. Louis.

SOCIETY OF CHEMICAL INDUSTRY. Gen'l Sec.: C. G. Cresswell, 9 Bridge St., Westminster, London. Sec., New York Section, T. J. Parker, 25 Broad St., N. Y. Annual meeting, Sept. 7-12, at New York.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 13, at Chicago.

VERMONT ELECTRICAL ASSOCIATION. Sec.: C. C. Wells, Middlebury. Next meeting, Sept. 21 and 22, at Montpelier.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. James W. Lyons announces his resignation as manager of the Power Department of the Allis-Chalmers Co. Mr. Lyons has taken this step in order to accept the appointment as consulting engineer to the Elgin Watch Company, of Elgin, Ill., who will erect new and extensive works under his supervision. Mr. Lyons will also engage in other consulting work, and his headquarters will be at Chicago.

—Mr. Wm. H. Armstrong, formerly manager of the New York business for the Chicago Pneumatic Tool Company, is now associated with the Ingersoll-Sergeant Drill Company, of 26 Cortlandt Street, New York, and will look after the interests of the Pneumatic Tool Department.

—Mr. Arthur Visick, formerly of the Napier Company, one of the most prominent manufacturers of motor cars in England, has been appointed representative for the Packard Motor Car Company, of Detroit, at St. Louis. Mr. Visick has had a wide experience abroad in connection with the Woolsey and Napier factories and is thoroughly posted on all the leading European cars; this experience will be of particular value to him in his present position in charge of the Packard exhibit in the Transportation Building at the St. Louis Fair.

—Mr. Roscoe Cornell has been appointed manager of the branch office which the Allis-Chalmers Co. has just opened in El Paso, Texas. Mr. Cornell goes to the Allis-Chalmers Co. from the Mine & Smelter Supply Co. of Denver. He is a graduate of the Michigan College of Mines, and is well known as a mining and mechanical engineer. He has held a number of prominent positions as a mining engineer, and as a smelter and mine superintendent. His acquaintance is extensive, and he is thoroughly qualified to fill the important position to which he has just been appointed.

Industrial Notes.

—Messrs. Gunn, Richards & Co., the well known production engineers, who have organized and installed cost-keeping systems in some of the largest engineering plants and manufacturing establishments in the country, have moved their offices to a suite of rooms in the Wall Street Exchange Building, 41 Wall St. and 49 Exchange Place, New York.

—The Brown Corliss Engine Co. have just opened a department for building high-speed engines and are now working on two units of 150 horse power each, three of 250

horse power, two of 50 horse power and one of 75 horse power, all to be direct connected. They have also recently shipped a 3,000-horse-power rolling-mill engine to the Lorain Steel Co., of Lorain, O.

—The Reeves Engine Company have opened a branch office at 2220 Land Title Building, Philadelphia, which will be under the direction of W. E. S. Dyer. Among the recent sales of this company are an engine to the Diamond Rubber Company, of Akron, O., for connection to a 150-kilowatt generator, and a vertical cross-compound engine to the Brier Hill Iron & Coal Company, for direct connection to a 250-kilowatt generator.

—The Grand Trunk Railway has compiled a little book telling about Canadian fishing resorts, how to get to them, rates, hotel accommodations, etc. This book may be obtained on application to G. T. Bell, General Passenger and Ticket Agent, Grand Trunk Railway System, Montreal, Quebec.

—The Chicago Bridge & Iron Works, of Chicago, are the builders of the turntable which forms part of the Big Four Route's striking exhibit at the St. Louis Exposition, where a locomotive and tender, built by the American Locomotive Co., with a total weight of 324,000 pounds, are shown in motion on the turntable, the latter moving also.

—The Westinghouse Companies' Publishing Department has issued a tasteful pamphlet on the "Westinghouse Industries, as Exemplified at the Louisiana Purchase Exposition," which contains accounts of the various Westinghouse companies, and descriptions and handsome illustrations of the principal works and of some of the important apparatus manufactured.

—The firm of Henry R. Worthington has published a small map showing the location of its old works in South Brooklyn, the offices in Manhattan and the new works at Harrison, N. J., with the intercommunicating lines of transportation. The old works were founded in 1840 and now cover about 4½ acres and employ 2,000 men. The new plant occupies a 34-acre tract, has 18 acres of floor space and will accommodate 6,000 workmen. It is said to be the largest industrial plant near New York, and embraces the latest improvements in production engineering.

—The O'Rourke Engineering & Construction Co., which firm has the contract for building the Pennsylvania Railroad Tunnel under the Hudson River, has placed an order with the Ingersoll-Sergeant Drill Co. for two central compressed-air power plants to be located at New York City and Weehawken, N. J. This order includes eight 36-inch stroke Corliss air compressors, each of 3,890 cubic feet capacity. With the O'Rourke plant installed, the total number of Ingersoll-Sergeant compressors supplying air for subaqueous tunnels in New York will be as follows: 6 Class "A" straight line compressors; 10 Corliss duplex compressors; 3 Class "H" duplex compressors; 2 Class "G" duplex compressors.

—Manning, Maxwell & Moore have secured a large order from the Illinois Central R. R., amounting to between $150,000 and $160,000 worth of tools, to be shipped to the various shops along their lines. This is one of the best orders for machine tools that has been placed in a long time. The order consists of a full line of railroad tools, such as driving-wheel lathes, axle lathes, car-wheel borers, steam hammers, large and small engine lathes, a very large quantity of punching and shearing machinery, woodworking tools, radial drills, shapers, bolt cutters, brass lathes, grinding machinery, planers, steel-tired-wheel lathes, slotting machines, vertical and horizontal boring machines, centering machines, a full line of tool room tools and milling machines. Manning, Maxwell & Moore have also secured the order for all the electric traveling cranes required to go with these tools.

—The Weston Electrical Instrument Company, of Newark, N. J., at the request of the Bureau of Statistics of Labor and Industries of the State of New Jersey, have prepared for the Louisiana Purchase Exposition a very tasteful and interesting pamphlet giving an account of their social features and, especially, of their Employees' Club. When the new Weston plant was built in the Waverly district of Newark, the Company reserved the most desirable portions of the premises, including several commodious halls, and furnished them as recreation room, library, kitchen, dining room, gymnasium, natatorium, bicycle depot, hospital, and so on. This entire outfit, with a working capital of $1,000 con-

tributed by a director, was formally transferred to the employees, who completed the formation and incorporation of the "Weston Employees' Club of Newark, New Jersey." This club is run entirely by the employees, acting through a board of governors and several standing committees, and is active in a number of ways. In the large dining room a bountiful and attractive lunch is served every day at an extremely reasonable price, either table d'hôte or à la carte. In the large recreation hall are pool and billiard tables, a baby-grand piano and pianola, chess, checkers, cribbage, dominoes and other games, and the commencement of a gymnasium, and here entertainments are held fortnightly, the performers being exclusively the employees themselves. Outside of the club, the greatest attention is paid to the health and well-being of the employees, and the lighting, heating, ventilating and sanitary arrangements of the factory are of the best and most modern kind. The pamphlet that has been referred to gives also some description of the works and buildings, is well illustrated, and presents a very attractive picture of harmonious and mutually beneficial relations between employers and employees at a highly successful establishment.

—Dodge & Day, Modernizing Engineers, Philadelphia, have lately completed the installation of the 340-horse-power Buckeye vertical, cross-compound engine, direct connected to two General Electric 100-kilowatt, continuous-current, compound-wound generators for the Link-Belt Engineering Company. The same concern are at work on a three-motor, electrically-operated locomotive crane for this company, to handle beams, angle irons and other heavy structural material for use in their new storage yard.

—The General Electric Company have selected Cochrane feed-water heaters for their plants at West Lynn, Mass., and Harrison, N. J., where Curtis steam turbines are to be installed. These heaters are rated at 3,000 and 1,000 horse power, respectively, and will take the exhaust steam from the auxiliaries. Three 5,000-horse-power Cochrane heaters have also been installed in connection with steam turbines at the Delway (Mich.) station of the Detroit Edison Co., and a 600-horse-power feed-water heater will be used in the new turbine station of the Iowa and Illinois Interurban Railway Co., Clinton, Ia. A 2,000-horse-power Cochrane heater which has been ordered by the Electric Co. of America will be installed with steam turbines in their new plant at Marion, Ind. All these Cochrane heaters are supplied by the Harrison Safety Boiler Works, of Philadelphia.

—The Eureka Fire Hose Co., of 13 Barclay St., New York, has a striking exhibit in Chief Hale's Fire Fighting Exposition at the St. Louis World's Fair, in the shape of a pagoda standing more than twenty feet high. The roof is constructed of play pipes, the side arches formed of Eureka hose, and the rest of the pavilion built of pipe couplings and other fire department material. The Eureka Company also has a fine exhibit in Machinery Hall, showing all its various products to advantage.

—The B. F. Sturtevant Co. is fitting up quarters in its big plant to be used for an emergency hospital, in case of accident to employees. It is to be equipped with all the appliances known to medical and surgical science for the proper care of the men who may get injured in the discharge of their duties until they can be removed to their homes. A graduate nurse and medical student will be in charge and a local doctor will attend to all surgical cases.

—The Frick Company, of Waynesboro, Pa., builders of the Eclipse ice making and refrigerating machinery, Corliss engines and steam boilers, have an elaborate display of their machinery at the St. Louis World's Fair, in the Agricultural Palace, Section 11. They have a small refrigerating plant in operation on the grounds and quite a number of various sized plants operating in the City of St. Louis or its immediate vicinity, to any of which their representative in charge, Mr. Jno. C. Emmert, will be pleased to personally direct.

—The International Congress of Arts and Science will be held at the St. Louis Exposition, September 19 to 25. The idea of the Congress grows out of the thought that the subdivision and multiplication of specialties in science has reached a stage at which investigators and scholars may derive both inspiration and profit from a general survey of the various fields of learning, planned with a view of bringing the

scattered sciences into closer mutual relations. The central purpose is the unification of knowledge, an effort toward which seems appropriate on an occasion when the nations bring together an exhibit of their arts and industries. An assemblage is therefore to be convened at which leading representatives of theoretical and applied sciences shall set forth those general principles and fundamental conceptions which connect groups of sciences, review the historical development of special sciences, show their mutual relations and discuss their present problems. The speakers to treat the various themes are selected in advance from Europe and America. The discussions will be arranged on the following general plan: After the opening of the Congress on Monday afternoon, September 19, will follow, on Tuesday forenoon, addresses on main divisions of science and its applications, the general theme being the unification of each of the fields treated. These will be followed by two addresses on each of the twenty-four great departments of knowledge. The theme of one address in each case will be the fundamental conceptions and methods, while the other will set forth the progress during the last century. The preceding addresses will be delivered by Americans, making the work of the first two days the contribution of American scholars. On the third day, with the opening of the sections, the international work will begin. About 128 sectional meetings will be held on the four remaining days of the Congress, at each of which two papers will be read, the theme of one being suggested by the relations of the special branch treated to other branches; the other by its present problems. Three hours will be devoted to each sectional meeting, thus enabling each hearer to attend eight such meetings, if he so desires. The programme is so arranged that related subjects will be treated, so far as possible, at different times. The length of the principal addresses being limited to forty-five minutes each, there will remain at least one hour for five or six brief communications in each section. The addresses in each department will be collected and published in a special volume. It is hoped that the living influence of this meeting will be yet more important than the formal addresses, and that the scholars whose names are announced in the programme of speakers and chairmen will form only a nucleus for the gathering of thousands who feel in sympathy with the efforts to bring unity into the world of knowledge.

—The International Railway Congress will hold its seventh session at Washington, from the 3rd to the 15th of May, 1905. This association includes many of the leading railroad men of the world, and the principal governments are formally represented at its sessions, which have been held at intervals since 1885, in some of the chief cities of Europe.

—The Power and Mining Machinery Company started business a little over a year ago, having secured the works of the Holthoff Mining Machinery Company at Milwaukee, where it immediately commenced extensive improvements for the manufacturing of its gas machinery. The extension of these works was begun in August, 1903, less than one year ago, and they are hardly completed, but will be ready within sixty days for extensive operations. In the meanwhile, the Company has taken upwards of a million dollars' worth of orders for Loomis-Pettibone gas apparatus and Crossley gas engines, which are being constructed in their shops at the present time. These orders have been placed with the most representative and conservative companies, among which are the following: —Velardena Mining & Smelting Company, Velardena, Durango, Mexico; F. W. Snow, Hillburn, N. Y.; Gould Coupler Company, Depew, N. Y.; D. Lovejoy & Son, Lowell, Mass.; Ramapo Iron Works, Hillburn, N. Y.; Pennsylvania Steel Company, Steelton, Pa.; Dufresne & Locke, Montreal, P. Q., Canada; Milford Electric Light Company, Milford, N. H.; Motor Engine Company, 15 William Street, New York City; Potosins Electric Company, San Luis Potosi, S. L. P., Mexico; Amparo Mining Company, Drexel Building, Philadelphia, Pa.; International Steam Pump Company, 114 Liberty Street, New York City; Atha Tool Company, Newark, N. J.; Elmira Water, Light & Railroad Company, Elmira, N. Y.; Sayles' Bleacheries, Saylesville, R. I.; W. H. Cone, Berlin, Ont., Canada; Bay State Forge, Cambridge, Mass.; Taylor Manufacturing Co., Columbia, S. C.; and others.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Belt Lacing Machine.

Booklet, with illustrations and descriptions of the Jackson belt lacing machine, both hand and power driven, and of wire coil clasp lacing, which makes a strong and flexible joint. 6 by 3½ in.; pp. 16. Diamond Drill & Machine Co., Birdsboro, Pa.

Boiler.

Catalogue, containing half-tone illustrations of the Rust water-tube boilers, in which the tubes are straight and vertical and the drums are fitted with the Rust patent pressed tube sheet, the advantages of which are clearly brought out. 9 by 6 in.; pp. 38. The Rust Boiler Company, Pittsburg.

Bolt and Nut Machinery.

Large catalogue, containing descriptions and illustrations of a great variety of bolt and nut machinery, forging and bending machines, wire nail, spike and special machinery, with tables of screw threads, nuts, bolts, rivets and other useful data, and an index. 8 by 10 in.; pp. 169. The National Machinery Co., Tiffin, O.

Cement.

Pamphlet, entitled "The Test of Time," devoted to "Giant" Portland cement, and giving illustrations of some of the great engineering works where this cement has been used, including the New York Rapid Transit Subway, the Williamsburg Bridge, the Rockville Bridge of the Pennsylvania Railroad, the New Croton Dam, the Wachusett Dam, the tunnel of the Niagara Falls Power Company, and many others. 6 by 9 in.; pp. 32. American Cement Co., 22 South 15th St., Philadelphia.

Centrifugal Pumps.

Catalogue No. 11, Revised, containing illustrations, descriptions and prices of many styles of centrifugal and suction pumps and pumping engines, turbine pumps, vertical steam engines, valves, connections and other fittings, and information about centrifugal pumping machinery. 6 by 9 in.; pp. 55. The Lawrence Machine Co., Lawrence, Mass.

Concrete Construction.

Pamphlet containing an interesting little treatise on concrete, its properties, and its applications, both alone and when reinforced by steel, with illustrations of various concrete structures. 9 by 6 in.; pp. 20. Engineering Company of America, 74 Broadway, New York.

Condensing Apparatus.

Booklet with illustrations of barometric and surface condensers, cooling towers and other types of condensing apparatus and vacuum and circulating pumps which have been manufactured and installed in connection with steam turbines and reciprocating engines where high vacuum is a necessity. 6 by 3½ in.; pp. 20. Alberger Condenser Company, 95 Liberty St., New York.

Conveyors.

Catalogue No. 67 A, containing descriptions and illustrations of Jeffrey "Century" rubber-belt conveyors, built in sections, with adjustable side guides and in other styles, with adjustable troughing and other kinds of carriers, for handling barrels, bags, packages, coal, ore and other materials, and also of other kinds of conveying and handling machinery. 9 by 6 in.; pp. 48. The Jeffrey Manufacturing Co., Columbus, O.

Core Boxes.

Circular, containing illustrations and price list of "Perfection" core boxes for accurate straight round cores from ½ inch to 6½ inches in diameter; with mention of other foundry supplies. 9½ by 6 in.; pp. 4. The J. D. Smith Foundry Supply Co., Cleveland O.

Crushers.

Booklet, describing and illustrating the Kimplen rock and ore crushers, with independent sets of jaws, of great capacity and very economical of power. 3½ by 6 in.; pp. 12. Also, booklet devoted to the K. mill, for pulverizing ores and other substances. 3½ by 6 in.; pp. 12. Kimplen Crusher and Pulverizer Co., 100 Washington St., Chicago.

Electric Driving.

"Industrial series" publication No. 13001, entitled "Machine Tool Drive," containing an instructive explanation and description of the advantages of electric driving for machine tools, illustrated with many views of all kinds of tools operated by electric motors. 9 by 6 in.; pp. 42. Westinghouse Electric & Manufacturing Co., Pittsburg.

Bulletin No. 1028, containing a well illustrated description of the Bullock multiple-voltage system of control for variable-speed electric motors adapted to the driving of machine tools. 9 by 6 in.; pp. 24. Also, pamphlet with illustrations and descriptions of representative types of Bullock electric apparatus, including some which is exhibited at the St. Louis Fair, and views of the Bullock works. 6¾ by 5½ in.; pp. 32. The Bullock Electric Mfg. Co., Cincinnati.

Electric Fans.

Leaflet No. 131, with illustrations of different styles of Northern electric motors driving, respectively, a Connersville cupola blower, a Bayley fan, an American Blower Co.'s fan, a Blackman fan, and a Buffalo forge blower. 6 by 3¼ in.; pp. 4. Northern Electrical Mfg. Co., Madison, Wis.

Engine Works.

Pamphlet, with description, half-tone illustrations and plan of the works of The William Tod Co., showing their excellent facilities for building steam engines and manufacturing heavy machinery. 10 by 8 in.; pp. 18. The William Tod Co., Youngstown, Ohio.

Gas Engines.

Large pamphlet, containing illustrations and descriptions of Cockerill blast-furnace-gas blowing engines and their valve gear, and also list of 121 Cockerill gas engines in use, in units of from 100 to 3,000 horse power, with a total of 80,000 horse power. 12 by 9 in.; pp. 11. The Wellman-Seaver-Morgan Co., Cleveland, O.

Gold Dredges.

Catalogue No. 2, with illustrations and descriptions of Bewsher sand pumps and gold-dredging machinery, including the combination suction-bucket dredge and monitor, in which are incorporated the suction dredge, the endless-chain bucket dredge, and the monitor or hydraulic giant for sluicing. 8 by 11 in.; pp. 15. General Construction Co., Seattle, Wash.

Locomotives.

Pamphlet containing illustrations and descriptions of twelve representative passenger and freight locomotives, exhibited at the St. Louis Fair, including a four-cylinder compound balanced locomotive for high-speed passenger service and a four-cylinder articulated locomotive for the heaviest freight service, the latter said to be the heaviest and most powerful locomotive ever built. 6 by 9 in.; pp. 44. American Locomotive Company, New York.

"Record of Recent Construction," No. 47, containing illustrations and descriptions of locomotives exhibited at the St. Louis Fair, including compound passenger and freight locomotives, electric locomotives, and various other types, and electric motor trucks; and also a historical review of the locomotives built at the Baldwin Works, with illustrations of every thousandth locomotive from the first, in 1832, to the twenty-four thousandth, in 1904, inclusive. 6 by 9 in.; pp. 77. Baldwin Locomotive Works, Philadelphia.

Machine Tools.

Booklet, with illustrations of gear-feed new model plain milling machines, plain horizontal milling machines, vertical milling machines, gear-feed new model universal milling machine, automatic gear cutting machine, cutter and reamer grinders, motor-driven planer-type milling machine, and other Becker-Brainard machine tools exhibited at the St. Louis World's Fair. 6 by 3½ in.; pp. 16. Becker-Brainard Milling Machine Co., Hyde Park, Mass.

Booklet, with half-tone illustrations of big-bore turret lathe, horizontal boring mill, vertical boring and turning mill, universal tool grinder and other machine tools. 6¾ by 5 in.; pp. 16. Also, bulletin leaves, devoted to new machinery and new methods of finishing various parts of machines. Gisholt Machine Co., Madison, Wis.

Pneumatic Machinery.

Pamphlet illustrating and describing the McGrath pneumatic railroad locomotive turntable motor and attachments; this motor may be operated by air from the shop plant or from the Westinghouse plant on the locomotive. 6 by 9 in.; pp. 8. Also, pamphlet devoted to McGrath pneumatic flue welders, flue welder and swedger and flue welder and scarfer. 9 by 6 in.; pp. 4. The Draper Manufacturing Co., Port Huron, Mich.

Pulverizers.

Catalogue, containing illustrations and descriptions of Straker's "Cyclone" disintegrators and pulverizers, for all kinds of materials, with either air or screen separation, the "Wilson" canvas-tube dust collector, the "Blake" rock and ore crusher, screens, bucket elevators, spiral conveyors, and other apparatus for pulverizing and disintegrating plants. 9¾ by 7 in.; pp. 64. E. H. Stroud & Co., 30-36 La Salle St., Chicago.

Catalogue, containing illustrations and descriptions of a complete line of pebble mills, in various styles, consisting of revolving cylinders containing flint pebbles or porcelain balls, for pulverizing all kinds of substances, "Max" vertical mills, cage disintegrators, rotary cutters, crushers, and other machinery. 9 by 6 in.; pp. 77. Abbé Engineering Company, 220 Broadway, New York.

Pumps.

Bulletin K 73, with illustration and description of the Knowles "Express" pump, and diagram giving result of test which showed an efficiency of 93 per cent. This pump is of the reciprocating type, directly connected to an electric motor without gears or belts, and runs at a speed of 300 revolutions per minute. 9 by 6 in.; pp. 4. Knowles Steam Pump Works, 114 Liberty St., New York.

Catalogue, containing illustrations and descriptions of the Emerson double-cylinder steam pump, particularly adapted for mines, quarries, irrigation, cofferdams, sinking, prospecting and similar work, and of the Emerson quick-cleaning strainer and foot valve, with useful data and tables. 9 by 6 in.; pp. 24. The Emerson Steam Pump Co., Washington, D. C.

Saw-Mill Machinery.

Catalogue, with descriptions and illustrations of high-speed saw-mill engine, band mills, band saws, resaws, timber yard saw mills, carriages, edgers, trimmers, log chains and sprockets, assorting lumber system, and other kinds of saw-mill and lumber machinery. 9 by 6 in.; pp. 107. McDonough Manufacturing Co., Eau Claire, Wis.

Vises.

Booklet, with illustration, description and price of the Humphrey heavy-duty vise, which weighs 175 pounds, has jaws 6½ inches wide and very deep in proportion to their length, and is very strong and well made in every way. 6 by 3½ in.; pp. 4. Humphrey & Sons, Joliet, Ill.

Wheel Press.

Circular No. 4, with illustration, description and price of the "Zelnicker" hydraulic wheel press, for forcing car wheels on to or off of axles, a very simple and substantial apparatus weighing only 1,250 pounds. 8½ by 3¾ in.; pp. 2. Walter A. Zelnicker Supply Co., St. Louis.

IMPROVED MACHINERY

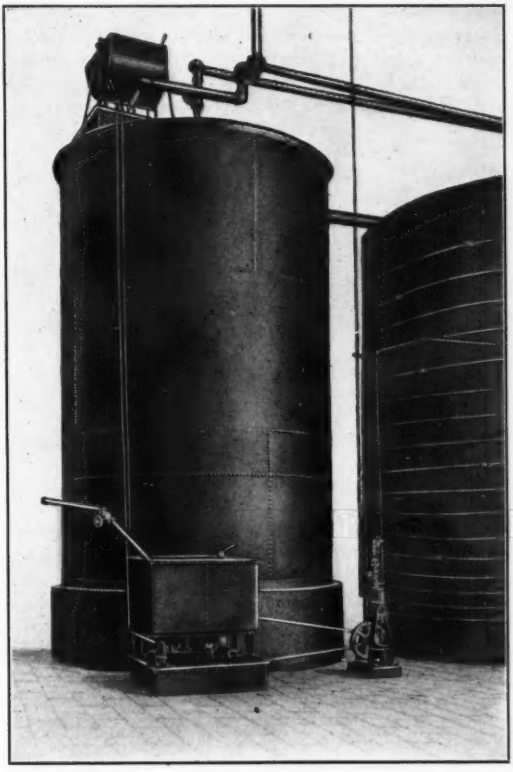
New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Brunn-Loewener System for Softening Water.

IT is hardly necessary to emphasize the importance of having pure water for use in boilers where safe and efficient steam generation is desired, and when the natural supply of water is hard or impure, it becomes of the utmost interest to secure an effective and reliable system of water purification.

All water-softening systems involve the use of chemicals to precipitate scale-forming substances before the water enters the boiler; but methods differ, and it is by the excellence of its methods that the Brunn-Löwener system obtains remarkable results.



AMERICAN WATER SOFTENER AT PIEL BROTHERS STARCH WORKS, INDIANAPOLIS.

This system, which was invented by a Dane, and is controlled in the United States by the American Water Softener Company,

involves apparatus of the simplest construction; there is practically nothing to get out of adjustment, and an ordinary fireman can give it all the attention it ever needs.

Lime and soda-ash, the cheapest reagents known, and purchasable in the open market, are used, and the apparatus mixes chemicals on the ground floor, which means a considerable saving in labor over other methods that make the elevation of chemicals necessary; while flowing water furnishes all the necessary motive power.

The lime *milk* used in this apparatus has a strength of 10 per cent., which being far greater than that of the lime-water used in some other systems, makes it possible to reduce in the same proportion the size of the tanks containing the lime. This effects a considerable saving of valuable space and renders practical the use of the Brunn-Löwener apparatus in plants that are cramped for room. The use of lime milk has this further advantage, that a fixed amount of freshly burned lime is mixed with a certain quantity of water, a solution being obtained the strength of which is always known.

The action is automatic; it starts and stops just as the water flows and stops flowing. No re-pumping into the storage tanks is needed, the water flowing into them from the top of the machine. Little attention is necessary, and it is very easy to mix a daily charge of chemicals, since the man in charge can do it without going to the top of the machine.

Of exceeding importance to the proper service of a water softener is the accurate mixing of chemicals and water, for it is only by such accuracy that the certain purification of water can be obtained. The tipping device in the Brunn-Löwener water softener absolutely assures this accuracy. The chemicals, which have been mixed on the ground floor to a certain strength, flow in definite amounts through the chemical valve above the tipper, at each oscillation of the tipper. A certain amount of water is needed to make this tipper oscillate, so that each tipperful of water is always treated with the correct amount of chemicals, whether the machine is running at full capacity or slowly.

Where the quality of water is changeable, it is only necessary to open and close the valve through which the chemicals flow, so that the correct amount of chemicals to be used, as shown by the very simple test of the water after treatment, can always be introduced.

Cases have been known where this apparatus was not looked after for months except for the addition of chemicals, and yet on testing the water it was found to be softened to the required degree, notwithstanding this long period of inattention.

Besides softening water for use in boilers, the Brunn-Löwener system may be used to great advantage for many other purposes. In laundries hard water plays havoc with soap. The lime salts in a thousand gallons of water will destroy 1.4 pounds of the best hard soap for each grain of carbonate of lime or its equivalent in the water, and this is all clear waste. Moreover the lime and magnesia in hard water combine with the fatty portion of the soap and form a greasy, insoluble and useless curd. This greasy curd gets into the fabric and resists rinsing; it spots and streaks the finished work. To soften the water means to save largely of soap, to make linen whiter, to prevent streaking and to give to laundering an appearance impossible to obtain with hard water.

In textile factories soft water shortens the time necessary for washing the cloth, makes it soft and smooth to the touch, and enables it to take the dye well and evenly. On the other hand, cloth treated with hard water is harsher, and the grease remaining in it from the soap prevents the dye from being properly absorbed, and has frequently the effect of dulling the colors.

In paper mills pulp absorbs impurities which can be precipitated and removed before the water is used.

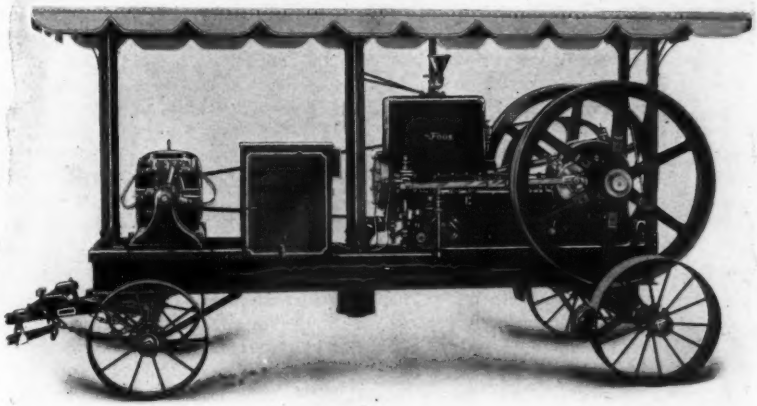
The Brunn-Löwener system has solved all manner of industrial problems involving the softening of water. By reason of its simple construction its first cost is low, and its operating expenses are also small.

Two general types of this apparatus are made: The rectangular, for the smaller industrial plants, and the upright for railroads and larger industrial plants, but the system is easily adjusted to changing conditions and requirements, and further information concerning it will be gladly furnished by the American Water Softener Co., Harrison Building, Philadelphia.

Portable Electric Power Plant.

WITH the perfection of the gasoline engine, it has become possible to design and construct a convenient and efficient portable electric power plant such as is shown in the accompanying illustration.

This outfit consists of a 22-horse-power Foos gasoline engine belted to a dynamo of corresponding capacity, and it is entirely self-contained, there being no accessory tanks, batteries or other details. It is mounted on a steel truck, and can be furnished with or without top and curtains. Such a portable plant may be employed to great advantage in operating electric tools, for temporary electric lighting, for thawing frozen water pipes, for running coal loaders, electric hoists and other contractors' apparatus and for many other purposes.



FOOS PORTABLE ELECTRIC POWER PLANT.

The gasoline engine is of the Foos portable type, and has the gasoline tank secured by brackets above the engine bed. The cylinder and water jacket are of a special design, and carry a sufficient supply of water to properly cool the cylinder. The water has a free passage to the air and maintains a uniform temperature, requiring no attention except that a bucket of water must be added occasionally to make up the loss due to evaporation. The cylinder is equipped with a complete water glass by which the height of water may be gauged. This method of cooling the cylinder does away with the cumbersome water tank and the circulating pump or fans often employed, and the advantages gained by freedom from water pipes and connections which may freeze or be broken by the vibration of operating and by hauling over rough roads, cannot be too strongly emphasized.

The Foos gas and gasoline engines are designed on the well-known four-cycle principle, giving an impulse at alternate revolutions of the flywheels. Nearly all the principal working parts being assembled on one side, the operator is enabled to install the engine to the best advantage, and to have free access to the devices for starting and for regulating speed, fuel and air supply, and time of ignition.

The system of ignition, on which depends in such a large measure the steady running and effective operation of an internal-combustion motor, has been very ingeniously worked out in these engines. The Foos igniter consists of two independent electrodes, the stationary and the revolving, each carrying a steel contact piece. The revolving blade coming in contact with the stationary spring at each revolution emits a large electric spark, while at the same

time the wiping action of the two parts removes any deposit of burnt carbon or scale and prevents the incrustation of the contact edges, which is often the cause of so much trouble. This rubbing action of the Foos igniter keeps the points of contact brightly polished under all conditions of operation and thus insures continuous and even ignition. The blade and spring are in frictional contact for their full width of about half an inch, and this large contact surface, together with the hardness of the special steel used, makes them very durable. Adjustment for wear is made by simply loosening a locknut and moving the stationary electrode screw one-half turn or more toward the revolving electrode, and, when necessary, the blades can be renewed quickly and at trifling cost.

The Foos governor is very simple and compact, and so placed as to be accessible but still well protected. It is of the centrifugal type and regulates the supply of fuel by cutting out the charges beyond those required to maintain the proper speed. Plain poppet valves, having vertical motion transmitted positively to both valves, are used.

Another distinctive feature of the Foos engine is the system of counterbalancing, in which discs are bolted to the arms of the crank, thus leaving the flywheels in balance, the latter having no weights cast in their rims, and bringing the counterbalancing weights in direct line with the piston, connecting rod, crank and other parts to be balanced.

The material is carefully selected, phosphor bronze being used in all main bearings, and steel forgings for connecting rod, crank and such parts.

The design of the Foos engine is such as to make all parts unusually accessible, it being possible to remove either valve, either portion of the igniter, the cylinder head and so on, without disturbing any other part of the engine, or any pipe, fitting or other connection. The workmanship is of a very high grade, and the facilities of the large Foos factory, which is fully equipped with up-to-date and special tools, are most excellent.

Further information regarding these gas and gasoline engines and portable electric plants will be gladly furnished by the Foos Gas Engine Co., of Springfield, Ohio.

The Atlantic Steam Shovel.

THE great expansion that has taken place in power and capacity of locomotives and rolling stock of railways now finds its counterpart in the necessity for corresponding increase in power and capacity of the steam shovel. Ten years ago the standard railway shovel weighed 25 tons and carried a dipper of 1½ cubic yards capacity. The shovel of to-day weighs 60 to 70 tons and has a dipper of 2½ to 3½ cubic yards. Shovels are in use which weigh 90 tons and carry a dipper of 5 cubic yards capacity. Mere weight and size, however, do not give efficiency in service. Great weight, which is necessary in a locomotive, is a disadvantage in a steam shovel, because it not only makes it cumbersome and difficult to hold on temporary rails and soft ground, but makes it slow of movement.

The steam shovel, of which the 2½-yard dipper size is herewith illustrated, is a new machine which is being introduced by the Atlantic Equipment Company. It is built by the American Locomotive Company from the designs of Mr. A. W. Robinson, M. Am. Soc. C. E. This machine is the result of many years' experience in the design and operation of steam shovels and dredging machines and it includes all the desirable features of the best modern practice in shovel building. The steam shovel has become an indispensable machine to railroad companies and contractors engaged in construction work and the present machine has been brought out to meet the demand for a high-class shovel of greater speed, power and capacity. This shovel is built on locomotive lines and the quality of the design and workmanship throughout is fully up to the best class of locomotive construction.

The shovel illustrated is one in use by the New York Central & Hudson River Railroad, and another shovel of this size is at work on the new Pennsylvania Railroad Terminal excavation, New York City. It is a Class 38-16-2½ machine. This means a shovel having a pull upon the dipper of 38,000 pounds, a clear height of lift of 16 feet and a capacity of 2½ cubic yards. This system of numbering expresses at once any combination of these three elements in a shovel and is more systematic than the use of arbitrary numbers or letters of the al-

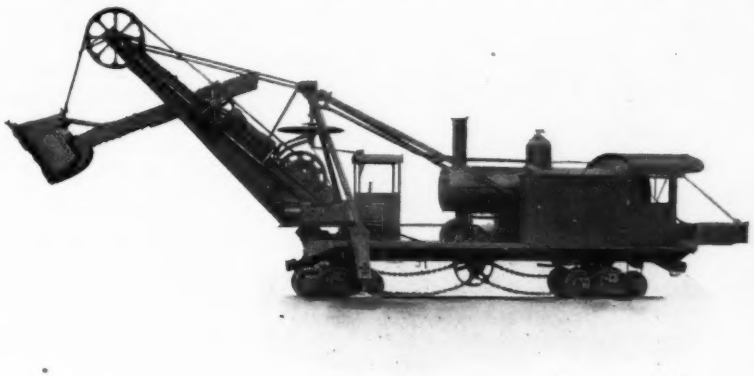
phabet commonly employed, which do not mean anything.

The distinguishing feature of this shovel is the direct wire-rope hoist. The friction loss in the chain hoist, to say nothing of the loss due to inertia, amounts to at least 40 per cent., whereas the loss in the case of direct wire rope hoist does not exceed 5 to 10 per cent. In the Atlantic shovel there is but a single sheave used for hoisting and this of very large size. This single sheave besides reducing friction has the very important advantage of increasing the angle of lead to the bucket. This is a most important feature, as it determines the digging efficiency of the machine. It is of but little use to exert a heavy pull upon the dipper by means of the hoisting chains if the angle formed by those chains on the dipper handle is so acute as to produce but little effect. In this shovel this angle is increased to such an extent that the digging effect is practically doubled. In other words, the same work can be done at higher speed and greater power and with a smaller expenditure of steam and less strain upon the machine.

The hoisting engines are incorporated in the base of the boom, so that the whole hoisting machinery revolves together. The A frame is formed of solid steel bars having solid forged pin connections at feet and a cast-steel head. The A-frame head is of new design and so arranged that the three strains intersect in a point, so obviating all lateral bending strains which frequently lead to breakage. In the boom there is a departure from the usual practice by making it with straight taper deepest at the inner end.

The entire frame of the engines is of cast steel in one piece and forms the foot of the boom and center of the turntable as well. While the weight of the engines and gearing is not great, it is located on the axis of rotation of the boom and therefore does not appreciably increase the power required for swinging nor interfere with the speed.

In this shovel everything is covered that needs to be covered and the rest is left off and no woodwork whatever is employed.



ATLANTIC STEAM SHOVEL.

The boiler is covered with magnesia blocks and heavy sheet steel, painted. The working parts of the swinging engines on the car are covered in with steel plate. All gearing is covered by a protecting plate over the teeth which keeps flying rocks from blasting from getting into them, and is also a protection for the operator.

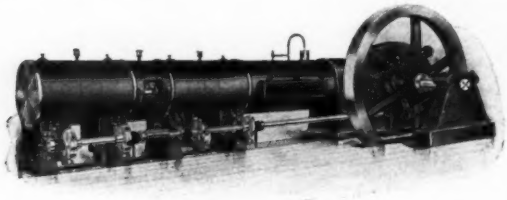
These novelties give the shovel a somewhat odd appearance to those accustomed to the usual housed-in shovel, but it is believed that in all vital and essential parts nothing is lacking to make a perfect machine and one which is on a distinctly higher plane as regards engineering design and quality of workmanship than any other.

Further particulars regarding this steam shovel will be gladly furnished by the Atlantic Equipment Co., of 25 Broad St., New York.

The Sargent Complete Expansion Gas Engine.

THE Sargent engine was not only the first successful double-acting tandem gas engine, but the first and only one to expand the burning charge to practically atmospheric pressure, to vary the point of cut-off of the admission inlet with the load, and to advance the time of ignition as the admixture gets weaker and the inflammation slower. The advantages thus secured over the ordinary gas engine are: increased efficiency, increased regularity in speed, and smooth running under early cut-offs.

The general design, as shown in the illustration, is not only symmetrical and pleasing to the eye, but is such that all the strains come in a straight line, while the free expansion of the cylinders and rods is provided for. The sub-base, the top of which comes flush with the floor line, extends from end to end of the engine, thereby giving a flat planed surface upon which the engine is easily erected and aligned. The sub-base and main frame are bolted to the foundation, and the cross-head guide, cylinders and distance head, which fasten to the main frame, can come and go as the temperature varies, sliding on the hollow supports rising from the sub-base, which not only maintain the cylinders in line, but convey the gas and air from the hollow divided sub-base to the explosion chambers, thus doing away with the pipes, ordinarily so unsightly and in the way.



SARGENT COMPLETE EXPANSION GAS ENGINE.

A side shaft driven by the crank shaft and governor through a pair of worm gears, running in oil, carrying two cams for each explosion chamber, one for the igniter and one to operate the valve, comprises all the moving mechanism except the valves and lever, as shown, the other side of the engine being perfectly plain.

In the ordinary gas engine, the piston at full load draws in a cylinder full of combustible mixture, which, after compression and ignition, is expanded to the original volume and released at a pressure of 40 to 50 pounds absolute, and a temperature of from 1500° to 1800° F. In the Sargent gas engine the admission of gas and air at full load is cut off from five-eighths to three-quarters of the admission stroke, depending on the fuel used, which, after compression and ignition, is expanded to the cylinder volume and is released a little above atmospheric pressure with a corresponding temperature of about 400° F.

While the governor controls the speed through all ranges of load, the gas engine, like the steam engine, is not economical with very light loads. Where a variation in the turning moment is not objectionable, one or more of the explosion chambers may be cut out at will by the engineer, by simply raising to horizontal position a controlling lever, which holds the exhaust open and the gas and air closed. This is very desirable in blowing engines as they can be designed so that two explosion chambers will furnish air at 15 pounds and the four chambers at 30 pounds pressure.

Two electric igniters are placed in each explosion chamber in such a position that they are surrounded with a pure mixture at the time of ignition. Either will fire the charge, and should either become short-circuited, the engineer is immediately advised.

The engine is started by compressed air. The pressure of the air when turned on at one cylinder puts the starting mechanism into operation and at the same time puts the cylinder out of service as a gas engine.

When the engine is up to speed, turning off the air puts the gas engine into commission without changing a valve, cam, or lever.

Every valve, lever, timing screw and part requiring adjustment, is readily accessible. All mechanism is above the floor line yet below the center line of engine. Every explosion chamber is accessible by simply removing the cylinder head, which can be done without further dismantling the engine. The time of ignition and the ratio

of the gas and air may be changed while the engine is in operation.

The Wellman-Seaver-Morgan Company, of Cleveland, Ohio, have secured the exclusive right to manufacture and sell the Sargent Complete Expansion gas engine. They are prepared to furnish these engines in units of from 100 horse power up, in single-cylinder tandem and twin tandem styles, and for all purposes, and will gladly furnish further details on application.

Bickford Semi-Radial Drill.

THE greatly increased demands upon high-grade machine tools make it necessary for the manufacturers of such machinery to be continually on the alert to introduce improvements and to keep their products up to the very exacting modern requirements.

One of the latest forms of a typical up-to-date tool is shown in the accompanying illustration of a Bickford semi-radial drill.

The chief characteristics of this machine are rigidity, simplicity and durability which, combined with a high ratio of transmission gears, make it an admirable tool for many classes of work.

The head, on which all bearings are of uncommon length, consists of a single casting and is adjustable on the arm by means of a spiral gear which gives it an easy quick motion.

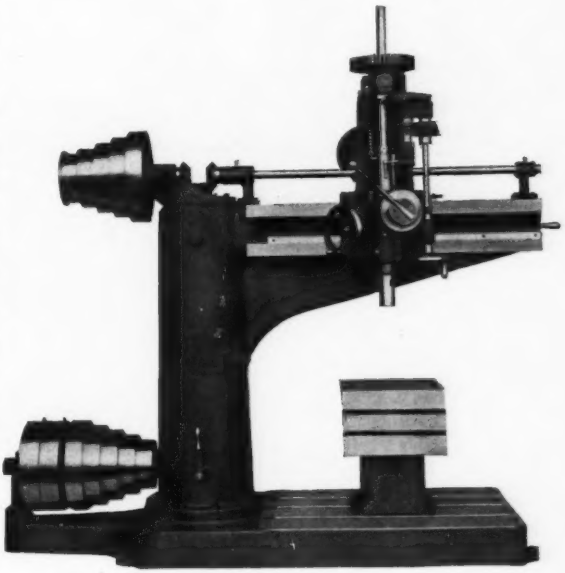
The spindle, which is made of hammered steel and has an unusually great vertical adjustment for a machine of its size, is provided with both hand and power feed and quick advance and return.

The feeding mechanism furnishes three rates of feed, advancing by even increments from .008 inch to .016 inch per revolution of the spindle, each of which is instantly available by means of our standard dive key.

The driving mechanism contains but seven gears, the pitch and periphery speed of which are conducive to long life. The speeds are five in number and advance in geometrical progression from 50 to 170 revolutions per minute.

The frame may be said to consist of but five parts, the base, column, cap, arm, and arm shaft, each of which are commensurate with the continuous severe work expected of a machine of this character.

The floor space required for this machine is 9 feet, 3 inches by 11 feet, 9 inches, and its net weight is 6,500 pounds. Further particulars will be gladly given by the manufacturers, The Bickford Drill and Tool Co., of Cincinnati.



BICKFORD SEMI-RADIAL DRILL.

Hancock Locomotive Inspirator.

THE Hancock locomotive inspirator, Type E, is the latest production of the Hancock Inspirator Co., and has been designed to meet the present demand of railroads in standardizing their equipment. This apparatus is a lifting inspirator and is

so made that by changing the nozzles and tubes only, it will be capable of delivering maximum capacities of 2,500 gallons, 3,000 gallons, 3,500 gallons, 4,000 gallons, 4,500 gallons, or 5,000 gallons per hour at a steam pressure of 200 pounds per square inch, lifting water 4 feet vertically with the feed water at 75 degrees Fahrenheit. By its use railroads are able to have one standard size inspirator for all sizes of locomotives, it being only necessary to insert in the inspirator the nozzles and tubes for the proper capacity to supply the locomotive. Thus only one size of spare inspirator and but one size of repair parts are required.

HANCOCK LOCOMOTIVE INSPIRATOR.

This inspirator is an ideal one for railroads desiring to standardize their equipment and reduce their supplies for maintenance to a minimum. In principle Type E is the same as the other types of well known Hancock inspirators, of which over 290,000 have been sold and are in use. It consists of a lifting apparatus which lifts the water and delivers it to the forcing apparatus, which in turn forces it into the boiler, the lifting apparatus acting as a governor, delivering the proper amount of water to the forcing apparatus for the proper condensation of the steam.

The great range of this inspirator demands more than ordinary attention. It is capable of feeding the boiler at any steam pressure between 35 and 350 pounds per square inch, without any adjustment of either the steam or water supply, and when the inspirator is in full working position at any of the above pressures, it cannot discharge the water except through the delivery pipe leading into the boiler. This inspirator will handle hot or cold water, and the capacity of each set of nozzles and tubes can be regulated for light or heavy service of the locomotive, so that the inspirator meets every requirement of a railroad having various types and sizes of locomotives.

The Type E inspirator is fitted with an extra heavy Hancock swing check valve, which has been found so efficient and reliable with the higher steam pressures carried on the modern locomotive and with bad feed water. The capacity is regulated by the regulating valve, which increases or decreases the steam to the lifting apparatus. It has been found that this method of regulation, which has been used with all Hancock locomotive inspirators for the past twelve years, has been a most efficient one. The valve seats are all independent of the body casting and can easily be removed for renewal or regrinding.

Great care is taken in the material used. Each part is made of a special mixture of metal to best resist the wear. The stems are made of Tobin bronze, and all the nozzles, tubes, valves and valve seats are of a composition which does not contain any

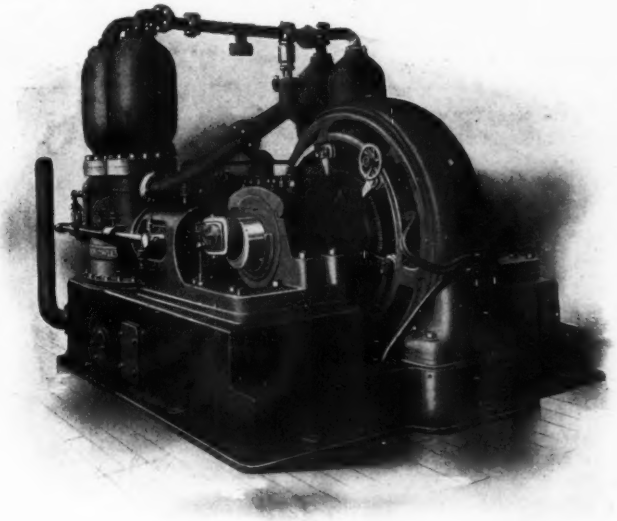
zinc. A capacity plate, showing the maximum gallons per hour delivered by the nozzles and tubes inserted, is fitted to the inspirator and clamped by means of a bolt, so that the engineer by glancing at it can tell at once the capacity of the tubes in the inspirator.

Any further information desired may be obtained from the Hancock Inspirator Co., 85, 87 and 89 Liberty St., New York.

A High-Speed Motor-Driven Pump.

THE operation of pumping machinery by electric motors offers, especially in mines, many obvious advantages, such as the centralization of the power plant, elasticity of extension of the system, high efficiency and small first cost and small expense for attendance. Compressed air may be used for the distribution of power to pumps, but it is not usually recommended on account of the low efficiency of the plant as a whole. Small leaks, if many, become serious, and the long line of piping with numerous joints causes frequent delay, trouble and expense. The use of steam for driving pumps at a distance and especially in mining operations, is decidedly objectionable on account of the loss by condensation, the heat from the engines and pipes, the expensive piping, the numerous joints liable to leak, and the possibility of danger from bursting pipes.

The electric-driven pumps, however, have had one drawback, which, while not serious, had nevertheless to be taken into account. This was the necessity of toothed gearing, belts or other devices to transfer the power from the rapidly revolving motor shaft to the slowly moving crank shaft of the pump. Such devices added to the weight and size of the pumping unit and required either careful attention or frequent repairs. The use of toothed gearing on pumps in buildings is objectionable, too, on account of noise.



BLAKE-KNOWLES HIGH-SPEED ELECTRIC PUMP.

In the pump which is illustrated herewith, these objectionable features have been eliminated by the simple expedient of connecting the pump plungers to cranks mounted directly upon the shaft of the motor. This pump has a capacity of about 250-gallons per minute against a 1,000-foot head when running at a speed of about 300 revolutions. So carefully have the internal parts of the pump been designed, however, that its mechanical efficiency is over 93 per

cent., approximating closely to that of the highest types of large steam pumping engines. The pump is of the duplex type; the cranks at the opposite ends of the motor shaft being set at right angles to each other. The plungers are of the outside-packed pattern, and the two plungers of each pump are connected by side rods. The plungers are 3½ inches in diameter and have a stroke of 5½ inches. In a very carefully conducted test, the pump proved a success in every way, surpassing the expectations of the purchasers and even of the builders. The volume of water pumped was measured by means of a carefully constructed and calibrated Freeman nozzle, and all gauges were tested before and after the test by means of a weight gauge tester. The pressure at the nozzle was measured by a mercury column connected to a piezometer chamber. Under the greatest pressure the pump showed a remarkably high volumetric efficiency. The operation was practically noiseless under all conditions and was unaccompanied by the slightest shock or heating.

This type of pump, which has only lately been introduced, has salient advantages never before attained, including simplicity of construction, small space requirements, and cheapness of installation and attendance. The pumps are built by the Blake & Knowles Steam Pump Works, 114 Liberty St., New York City, in capacities of from 200 to 4,000 gallons per minute, and for heads varying from 100 to 2,000 feet, and further particulars may be obtained upon request.

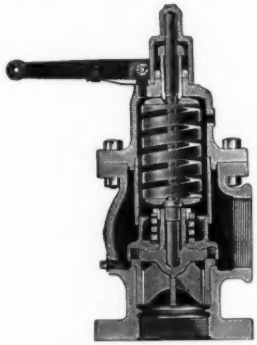
Crane Pop Safety Valves.

THE modern high pressures of steam and the all-round development of steam engineering make it necessary for the safety valve to keep pace with the general advance.

Realizing all this, the Crane Co., who have had a wide experience in the manufacture of valves, have brought out a number of improved forms of pop valves for stationary, marine, locomotive and portable boilers.

The construction of these valves embodies a self-adjusting feature which automatically regulates the "pop" of valve, or in other words, maintains the least waste of steam between the opening and closing points, an improvement which will be readily appreciated, as there is no necessity for re-adjusting to regulate the pop on changes in the set pressure.

This is more clearly explained as follows: In all pop safety valves it is necessary to have a pop or huddling chamber into which



CRANE ENCASED SPRING POP SAFETY VALVE.

the steam expands when the main valve opens, thereby creating an additional lifting force proportionate to this increased area and greater than the force of the spring, thus holding the valve open until the pressure is relieved. Means must also be provided to relieve this pop chamber of pressure, in order to allow the valve to close promptly and easily. This is accomplished in the present valve by the self-adjusting auxiliary valve and spring, which are entirely independent of the main valve and spring. The steam in the pop chamber finds a passage through holes or ports into an annular space provided in the auxiliary valve or disc, and by reason of the light auxiliary spring, this pressure lifts the auxiliary valve and allows the steam in the pop chamber to gradually escape, thus permitting a greater range in setting pressures with the least waste of steam, and at the same time supplying a cushion or balancing medium, which prevents any chattering or hammering and affords the easiest possible action in closing.

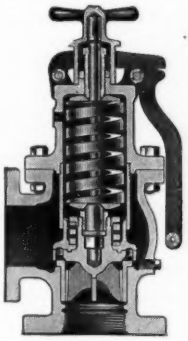
This feature is embodied in no other make of valve, and unlike other pop valves, in changing set pressures within reasonable limits of the spring capacity, nothing fur-

ther is to be done but to simply turn down or out (for a higher or lower pressure) on the screw pressure plug at the top of the valve.

The encased spring valves are constructed with a casing or chamber enclosing both springs, so protecting them against the action of the steam, particularly high-pressure steam, which, blowing with great force and velocity throughout all parts of valve before reaching the atmosphere, would otherwise have a tendency to disarrange the springs and other parts operating in connection therewith.

This form of valve is also especially useful, in fact, necessary, where a number of valves may be connected to one main exhaust or discharge pipe. The encased spring chamber, extending over a greater portion of the top surface of the main valve, prevents any retarding action of the steam due to back pressure, which might be caused by one or more valves opening slightly in advance of others, from having any material effect on the free opening of the other valves.

The composite marine pop valves made by the Crane Co. have been approved by the United States Board of Supervising Inspectors of Steam Vessels and comply fully with all the rules and regulations governing the United States Steamboat Inspection Service.



CRANE MARINE POP SAFETY VALVE.

They have bevel seats at an angle of 45 degrees from the center line of their axis. The seats are made of composition or with solid nickel bushing, as may be required. The cam lever is capable of lifting the valve off its seat one-eighth the diameter of valve opening, whether or not there is pressure on the boiler. The cam lever may also be thrown over far enough to lock the valve open should occasion require or if it is desired to blow off all or a portion of the steam from the boiler through the safety valve.

The cap is made with handles or cross bars and fastened to the stem by a key pin. The stem in turn is securely attached to the main or wing valve, and, having a square section operating in a square socket or recess in the main valve, affords means of turning the valve on its seat, thereby removing any incrustation or saline matter that may accumulate.

There is a self-adjusting pop regulator which automatically controls and maintains a minimum waste of steam between the opening and closing points, and there are encased springs, made of the best steel and with self-adjusting spring discs.

The valves can be taken apart without removal from the boiler and without disturbing the outlet pipe. All parts have been carefully designed and strongly proportioned, and when fitted and adjusted with correspondingly strong springs, these valves are suitable for pressures up to 250 pounds. Special valves for higher pressures are made to order.

The valves are furnished locked-up to prevent tampering, and further information concerning them may be obtained from the manufacturers, the Crane Co., of Chicago.

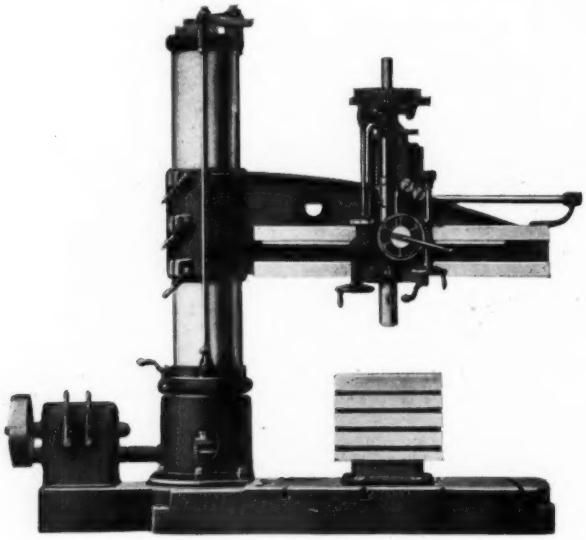
American Plain Radial Drill.

RADICAL changes have taken place, in the past few years, in the construction of radial drills. In order to keep fully abreast of the altered conditions and greatly increased duties now confronting the radial drill, the American Tool Works Co. have just redesigned their line of radial drills throughout, taking into account every condition influencing modern radial drill work, and every point which would tend to increase the efficiency of these tools. In the accompanying illustration is shown their new improved plain radial drill, which can be furnished with 4-foot, 5-foot, 6-foot or 7-foot arms. A feature of unusual excellence in this new drill is the feeding mechanism in the head, an entirely new and original construction. It provides eight distinct rates of feed to the spindle. These feeds are all obtained by the simple turning of a dial shown on the feed box, until the desired feed, indexed thereon, comes opposite a fixed pointer. This method is an extremely simple one, as it requires no reference to index plates and subsequent hand-

ling of levers. The feeds operate through a friction, which permits a drill being crowded to its limit without strain to the feed works. A plate is provided, indicating twist drill sizes, from ½ inch to 3½ inches, inclusive, and their respective feeds, and this, in connection with the dial index enables the operator to immediately secure the proper feed for the twist drill he is using. This involves no guesswork, saves a great deal of time, and insures the drill being used to its full capacity. Feeds can be automatically tripped at any position of the spindle by adjustable trip dog and pointer, acting on the worm clutch. Depth graduations are on the spindle, and all depths can be read from zero. Two or more dogs can be supplied, making it possible to counterbore any number of holes without resetting. The trip acts automatically at the full depth of spindle, so preventing breakage of feed mechanism.

The speed box is of the geared friction type, four changes of speed being instantly available by use of the two levers shown. The frictions are of the patent double-band type, employing very few parts in their construction, and they can thus be made of such large proportions as to be free from slippage under the severest cuts, so obviating the use of loose delicate parts. A motor of any type may be readily attached at any time, connection being made through chain, gear or belt. The speed box can be easily interchanged with a cone by simply breaking a coupling connection on the lower driving shaft of the machine.

The spindle has sixteen changes of speed, all instantly available without stopping the machine. This wide range of spindle speeds, combined with the exceptional driving power of the machine, renders the drill equally efficient with either ordinary or high-speed twist drills.



AMERICAN PLAIN RADIAL DRILL.

The column is of the double tubular type. The outer column is practically integral with the inner column, which extends the entire height and has full bearing for the outer column at both top and bottom.

The arm is of parabolic beam and tube section, giving the greatest resistance to bending and torsional strain. Its design leaves the lower line parallel with the base, and thus permits work being operated upon in close proximity to the column without the necessity of an extreme reach of spindle. The arm is raised and lowered rapidly by a double-thread, coarse-pitch screw hung on

ball bearings, and controlled instantly by a convenient lever.

Further particulars will be cheerfully furnished by the makers, the American Tool Works Co., of Cincinnati.

The Bitulithic Pavement.

FOUR years ago there was introduced to the engineering world a new style of street paving which was laid in Pawtucket, R. I., and it at once enlisted earnest attention, as it was a radical departure from all accepted forms of roadway. A few thousand yards of this paving, which is now universally known as the Bitulithic pavement, were designedly laid in locations which would develop any weaknesses the pavement might possess. One section was constructed in Harvey Street, a much traveled way having a 12 per cent. grade, and another in Park Place near the entrance to the principal fire engine station in the city.

The pavement was watched with the greatest care in order to discover any weaknesses, and tours of inspection were made to Pawtucket by hundreds of engineers, city officials and practical road builders for the express purpose of investigating the Bitulithic. The patentees of the Bitulithic pavement, the Warren Brothers Company, the members of which firm had beeen identified with the asphalt industry from its inception in the United States to the introduction of the Bitulithic pavement, offered every facility for investigation by throwing open to the public their laboratories, being as anxious to discover any minor defects as any one in order that they might be remedied, their faith in the inherent qualities of their invention being unassailable. From the small beginning in Pawtucket of 2,100 square yards, which in four years has not cost a penny for repairs and is as good today as when originally laid, the business of the company grew in the first year to 16,400 square yards, laid principally in experimental stretches in sections most likely to disclose any weaknesses it might possess; but none were found, and practical tests under traffic showed that it bore out in every particular the claims of the patentees, which are, that the stone of which it is composed takes the wear of traffic; it is less noisy than any other pavement; it will not rot and disintegrate; horses will not slip on it in any weather; it is free from dust and mud; and it can be successfully laid on top of old stone blocks, bricks, macadam or asphalt, if they have not rotted.

The investigations of the Bitulithic pavement in its early life bore abundant and early fruit, as in 1902 it was adopted in 32 cities to the extent of 365,932 square yards; in 1903 in 40 cities to the extent of 800,071 square yards; and up to August 1 of the present year contracts have been awarded in 42 cities for over one million square yards.

Nine miles of the Bitulithic pavement have been laid in St. Louis, Mo., Lindell Boulevard, the principal thoroughfare leading to the main entrance of the Louisiana Exposition being among the streets so paved.

The beginning of the Warren Brothers Company was a modest one, a single small office in Boston being deemed sufficient for immediate needs, but the business soon outgrew these cramped quarters and development since has been so great as to compel two removals, until at the present time an entire floor in one of the largest office buildings in Boston and fifteen branches in the principal cities of the United States are required to attend to the rapidly increasing demand for the Bitulithic pavement.

Boring and Turning Mill with Turret Head.

A THIRTY-INCH boring and turning mill with turret head, equipped with a full set of adjustable tools for finishing gear blanks ranging in size from 4 inches to 24 inches in diameter with but two settings, is shown in the accompanying illustration.

The blank is secured by finger jaws gripping the inside of the rim. It is readily brought to true by the combination chuck in the table, and is brought level with the table by the parallel blocks on which it rests.

The upper tool holder, carrying a four-lip core drill, an outside turning tool and two facing tools for the rim and the hub, respectively, completely roughs one side of the blank while the hole is being rough bored.

A single point boring tool is next run through the bore at a racing cut to insure concentricity, leaving just enough metal to be cleaned up by a special universal joint

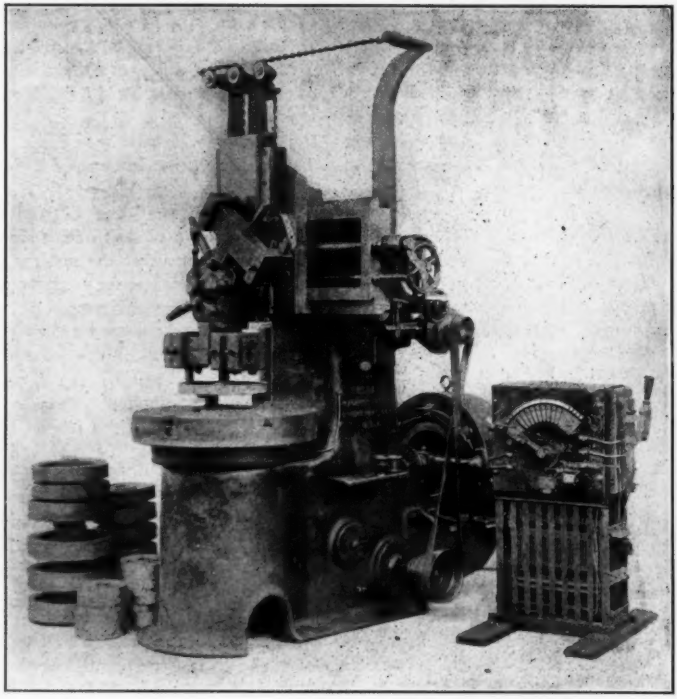
reamer to finish the bore absolutely true and to size.

The lower tool holder is of the same design as the upper one, but carries a standard sized guide plug which, in entering the bore, insures concentricity of diameters and also adds to the stability of the tool. A second tool finish-turns the outside diameter of the blank to size, and has completed its operation before the finish-facing tools are brought into action on the rim and the hub. The corners of the rim and hub are rounded off by two other tools.

In the second setting a stud (the diameter of the bore of blank) is fitted into the center of the hole in the table and a driving stud set in the T slot of the chuck jaw. A blank is then dropped over it, and the upper tool holder, minus the four-lip core drill and the outside turning tool, roughs the faces of the rim and the hub, which are finished by the corresponding tools in the lower tool holder, the rounds being formed as before by the appropriate tools.

The method of holding the blank from the inner surface of the rim insures uniform thickness of the rim when finished, and, by the use of the guide plug in the finishing tool, the outside diameter is not only turned absolutely true to size but runs on centers within .0005 of an inch.

The tools used in the holders number twelve, and all operations are completed without moving the turret slide from its central position on the rail, thereby saving all the time usually required to set tools and caliper for diameters.



BULLARD TURNING AND BORING MILL WITH TURRET HEAD.

All gears of the above sizes are finished in this way at the shops of The Bullard Machine Tool Co., Bridgeport, Conn., and a saving of from 50 to 75 per cent. is made over the more common method of separate chucking and turning on arbors. Further information concerning these tools and operations will be gladly furnished by the above-named company.

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SEPTEMBER, 1904
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THE ENGINEERING MAGAZINE

AN INDUSTRIAL REVIEW

EDITED BY JOHN R. DUNLAP
CHARLES B. GOING AND HENRY HARRISON SUPLEE.

THE NEW YORK RAPID-TRANSIT SUBWAY—
Its History, Construction, Equipment, and Power Plant — H. C. Fyfe — 881

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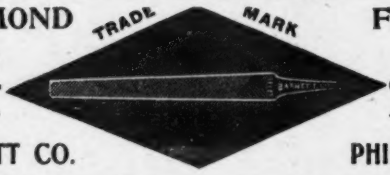

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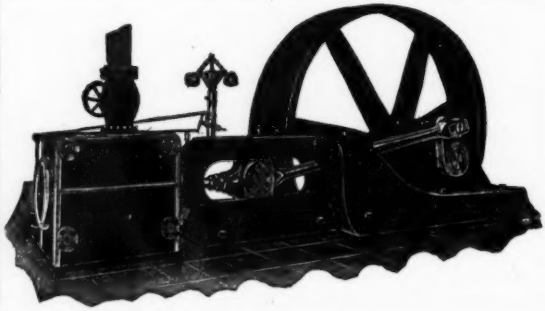

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AUTHORS AND PAPERS FOR SEPTEMBER, 1904.

HERBERT CHARLES FYFE (*The New York Rapid-Transit Subway*)—Born in London, 1873; died at Ventnor, March 26, 1904. Educated at St. Paul's school; acted as assistant secretary at the Royal Institution, 1890-1902; contributed largely to the press on scientific subjects; in 1902 published "Submarine Warfare," the first work dealing comprehensively with the subject; the book was widely noticed, translated into several languages, and by the Admiralty was ordered placed in the libraries of all ships in the British navy. At the time of his death he was engaged on a volume dealing with the problems of traction by railway, tramway, etc., but the sudden acute turn in his illness cut him off with this work unfinished.

A. D. WILT, JR. (*How to Introduce High-Speed Steel into a Factory*)—A graduate of Lawrence Scientific School, Harvard University, in recent charge of the engineering laboratory of the National Cash Register Company. The article prepared by Mr. Wilt is the fruit of six weeks of special study, involving the investigation of the methods of manufacturers in Boston, Providence, Springfield, Hartford, Waterbury, New Haven, Stamford, New York, Philadelphia, and Pittsburg, in addition to his experience in his own company's establishments. The method proposed is a composite, designed to be suitable for almost any class of manufacturing in which steel tools are used.

G. C. CUNNINGHAM (*Past and Present of Precious-Metal Mining in Mexico*)—The writer has been a resident of Mexico for many years past and is thoroughly conversant with the subject under discussion. The technical data have been revised also by a mining engineer of long Mexican experience, and are pronounced by him perfectly reliable.

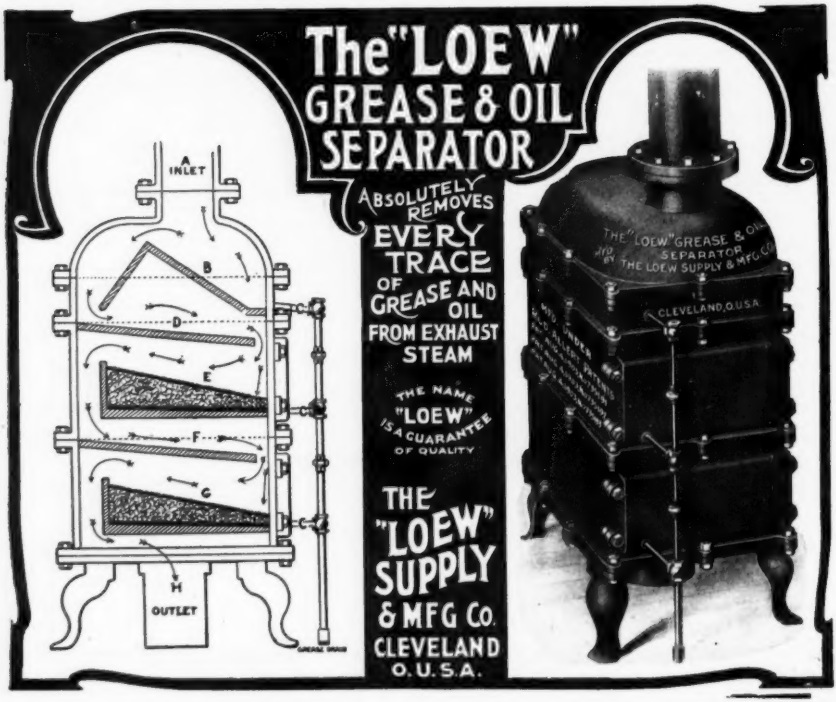
FRANK T. CARLTON (*The Industrial Value of the Manual-Training School*)—Born Ohio, 1873; entered Case School of Applied Science on a prize scholarship, 1891, and graduated 1895 (B. S.) and 1898 (M. E.); studied in the summer terms of the University of Michigan, 1898 and 1900; Cornell University, 1901; University of Chicago, 1902 and 1903; draftsman in Cleveland, 1895-1896; teacher, Toledo University School, 1896 to date; contributor to *Popular Science Monthly, Annals of the Academy of Political and Social Science, Yale Review, Sewanee Review, Education,* etc.

AUTHORS AND PAPERS FOR SEPTEMBER, 1904.

ENRICO BIGNAMI (*The Mines and Mineral Industries of Italy*)—A prominent electrical engineer of Italy, especially well qualified by his extensive experience to speak of the progress of electrical undertakings, especially in connection with the numerous water-powers of Italy for the development of electrical energy; director of the technical journal *L'Elettricita.*

WILLIAM ERNEST DALBY (*The Development of the Compound Locomotive in England*)—Professor of mechanical engineering, City and Guilds of London Institute; Finsbury Technical College, London, M. A.; Cambridge, B. Sc. London; member of the Institution of Civil Engineers; member of the Institution of Mechanical Engineers; author of a treatise on the Balancing of Engines, and a well-known authority upon locomotives and other steam machinery. Professor Dalby recently visited the United States at the instance of Mr. A. F. Yarrow to report upon the systems of technical apprenticeship and education there, and his report, presented before the Institution of Mechanical Engineers, attracted wide-spread attention and comment.

PERCIVAL ROBERT MOSES (*The Electrical Equipment of Workshops and Factories*)—Born in New York; educated in Europe and the United States; entered the School of Mines of Columbia College in 1891 and graduated in 1895-6 with the degree of Electrical Engineer; was for some time with the Sprague Electrical Company in factory and construction work; is now practising as consulting engineer; associate member of the American Institute of Electrical Engineers.



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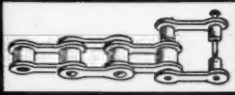

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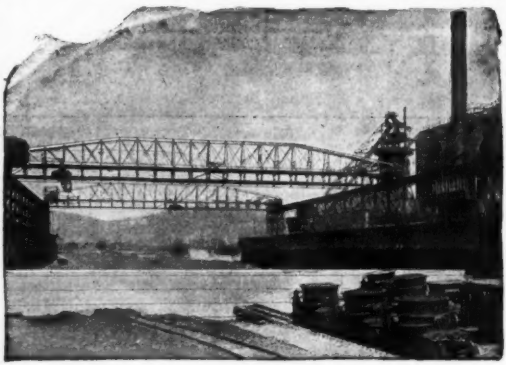

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The Buyers' Directory

OF

THE ENGINEERING AND MACHINERY TRADES

NOTE.—The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page 11.

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Gunn, Richards & Co., 41 Wall St., New York.

Accumulators, Hydraulic.

Niles-Bement-Pond Co., 136 Liberty St., New York.
Watson-Stillman Co., 46 Dey St., New York.

Adding Machines.

C. E. Locke Mfg. Co., Kensett, Iowa.

Addressing Machines.

B. F. Joline & Co., 123 Liberty St., New York.

Aerial Tramways.

Broderick & Bascom Rope Co., St. Louis, Mo.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 95 Liberty St., New York.
Trenton Iron Co., Trenton, N. J.

Air and Gas Compressors.

Allis-Chalmers Co., Chicago, Ill.
American Air Compressor Works, 26 Cortlandt St., New York.
American Well Works, Aurora, Ill.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Blanchard Machine Co., Boston, Mass.
Clayton Air-Compress. Wks., 26 Cortlandt St., N. Y.
Contractors' Supply & Equipment Co., Chicago, Ill.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Hall Steam Pump Co., Pittsburg, Pa.
Hanna Eng'ng Works, 820 Elston Ave., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.
E. W. Irwin Machinery & Supply Co., 114 Liberty St., New York.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Pneumatic Engineering Co., New York City.
Providence Engineering Works, Providence, R. I.
Rand Drill Co., 128 Broadway, New York.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Union Steam Pump Co., 44 So. Madison St., Battle Creek, Mich.
Vulcan Iron Works, Wilkesbarre, Pa.
Henry R. Worthington, 118 Liberty St., New York.

Air Brakes.

Westinghouse Air Brake Co., Pittsburg, Pa.

Air Drills.

Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.

Air Hoists.

Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Hall Steam Pump Co., Pittsburg, Pa.
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Pneumatic Engineering Co., New York City.

Air Motors.

Philadelphia Pneumatic Tool Co., Philadelphia, Pa.

Alumino-Thermics.

Goldschmidt Thermit Co., 43 Exchange Pl., N. Y.

Ammeters.

Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.

Angle Bars and Splices.

Continuous Rail Joint Co. of Am., Century Bldg., Newark, N. J.

Anti-Friction Metals.

Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
Poole Engineering & Machine Co., Baltimore, Md.
Paul S. Reeves & Son, Philadelphia, Pa.

Architectural Iron Work.

Lyon Metallic Mfg. Co., 18 So. Ann St., Chicago Ill.

Architectural Metal Work.

G. Drouvé & Co., Bridgeport, Conn.

Arc Lamps—SEE LAMPS, ELECTRIC.

Assayers' and Chemists' Supplies.

F. W. Braun Co., Los Angeles, Cal.

Automobiles.

Electric Vehicle Co., 100 Broadway, New York.

Ballast Unloaders.

Broderick & Bascom Rope Co., St. Louis, Mo.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Marion Steam Shovel Co., Marion, Ohio.

Ball Bearings.

American Ball Co., Providence, R. I.
Ball Bearing Co., Philadelphia, Pa.
Hess-Bright Co., Philadelphia, Pa.

Ballcocks.

Julian D'Este Company, 24 Canal St., Boston, Mass.

Band Saws.

Fay & Egan, 212-232 W. Front St., Cincinnati, O
Frank Machinery Co., Buffalo, N. Y.

Bed Spring Machinery.

Hoefer Mfg. Co., 100 Chicago St., Freeport, Ill.

Belt Conveyors.

Ridgway Belt Conveyor Co., 29 B'way, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Belt Dressing (Waterproof).

Jos. Dixon Crucible Co., Jersey City, N. J.

Belting.

Boston Belting Co., Boston, Mass.
Buhl Malleable Co., Detroit, Mich.
Case Mfg. Co., Columbus, Ohio.
Eureka Fire Hose Co., New York City.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Engineering Co., Philadelphia, Pa.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
Ridgway Belt Conveyor Co., 29 B'way, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Belt Lacing.

Bristol Co., Waterbury, Conn.

Belt Lacing Machines.

Diamond Drill & Machine Co., Birdsboro, Pa.

Bending Rolls.

Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Fillos & Jones Co., Wilmington, Del.
Niagara Machine & Tool Works, Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New York.

Blast Furnaces.

Chicago Flexible Shaft Co., 154 La Salle St., Chicago, Ill.
Walter Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Wm. B. Pollock Co., Youngstown, Ohio.
Riter-Conley Mfg. Co., Pittsburg, Pa.

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American Gas Furnace Co., 23 John St., New York.
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B. F. Sturtevant Co., Boston, Mass.

Blue Prints.

Kolesch & Co., 138 Fulton St., New York.

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American Drafting Furniture Co., Rochester, N. Y.
Pittsburg Blue Print Co., Pittsburg, Pa.
Keuffel & Esser Co., 127 Fulton St., New York.
Kolesch & Co., 138 Fulton St., New York.
Spaulding Print Paper Co., 44 Federal St., Boston, Mass.
Williams, Brown & Earle, 918 Chestnut St., Philadelphia, Pa.

Blue Print Paper.

Spaulding Print Paper Co., 44 Federal St., Boston, Mass.

Boiler Compounds

Pittsburg Boiler Scale Resolvent Co., Pittsburg, Pa.
burg, Pa.
John Simmons Co., 110 Centre St., New York.

Boiler Fronts and Fittings.

John Simmons Co., 110 Centre St., New York.
Vulcan Iron Works, Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Boiler Inspectors.

Hartford S. B. I. & Ins. Co., Hartford, Conn.

Boiler-Makers' Tools.

Hilles & Jones Co., Wilmington, Del.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.

Boilers.

Allis-Chalmers Co., Chicago, Ill.
American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Atlas Engine Works., Indianapolis, Ind.
Babcock & Wilcox Co., 85 Liberty St., New York.
Bradley Mfg. Co., Pittsburg, Pa.
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Contractors' Supply & Equipment Co., Chicago, Ill.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Heine Safety Boiler Co., St. Louis, Mo.
Kingsford Foundry & Machine Co., Oswego, N. Y.
P. B. McCabe & Co., 602 N. Main St., Los Angeles, Cal.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Robb-Mumford Boiler Co., Inc., 170 Summer St., Boston, Mass.
Stirling Co., Chicago, Ill.
Struthers-Wells Co., Warren, Pa.
Tippett & Wood, Phillipsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.
Wickes Bros., Saginaw, Mich.

Bolt and Nut Machinery.

Acme Machinery Co., Cleveland, Ohio.
Howard Iron Works, Buffalo, N. Y.
The National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., 136 Liberty St., New York.

Books.

Spon & Chamberlain, 123 Liberty St., New York.
Association of Engineering Societies, Phila., Pa.
Henry Carey Baird & Co., 810 Walnut St., Philadelphia, Pa.
Eng'g Magazine Press, 140-142 Nassau St., N. Y.

Boring Bars.

H. B. Underwood & Co., 1025 Hamilton St., Philadelphia, Pa.

Boring Mills.

Bullard Machine Tool Co., Box 1055, Bridgeport, Conn.
Frank Machinery Co., Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pond Machine Tool Co., Plainfield, N. J.

Box Makers' Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Frank Machinery Co., Buffalo, N. Y.

Brass Founders' Supplies.

J. D. Smith Fdy. Supply Co., Cleveland, O.

Breast Drill, Electric.

Jas. Clark, Jr., & Co., Louisville, Ky.

Brick.

Henry Maurer & Son, 420 E. 23d St., New York.
National Pyrogranit Co., 17 Battery Place, New York.

Brick and Tile Machinery.

American Blower Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.

Briquetting Machinery.

American Briquetting Machinery Co., Empire Bldg., Pittsburg, Pa.

Buckets, Automatic.

W. J. Clark Co., Salem, Ohio.
Cyclopean Iron Works, 402 Claremont Ave., Jersey City, N. J.
Coburn Trolley Track Mfg. Co., Holyoke, Mass.
Hayward Co., 97 Cedar St., New York.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Bulldozers.

National Machinery Co., Tiffin, Ohio.
Niles-Bement-Pond Co., 136 Liberty St., New York.

Cable-Railway Machinery.

Allis-Chalmers Co., Chicago, Ill.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Poole Engineering & Machine Co., Baltimore, Md.

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General Electric Co., New York.
Sprague Electric Co., 527 W. 34th St., New York.

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Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.

Cableways—Wire Rope.

A. Leschen & Sons Rope Co., St. Louis, Mo.

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Broderick & Bascom Rope Co., St. Louis, Mo.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
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Calculating Machines.

Calculagraph Co., 9-13 Maiden Lane, New York.
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C. E. Locke Mfg. Co., Kensett, Iowa.

Carborundum.

Carborundum Co., Niagara Falls, N. Y.

Card Index Systems.

Globe-Wernicke Co., Cincinnati, Ohio.

Cars.

Continental Car & Equipment Co., Whitehall Bldg., New York.
Arthur Koppel, 66-68 Broad St., New York.
G. L. Stuebner Iron Works, Long Island City, N. Y.

Car Shop Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
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Carriage and Wagon Machinery.

American Blower Co., Detroit, Mich.
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Frank Machinery Co., Buffalo, N. Y.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

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Walworth Manufacturing Co., Boston, Mass.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Cast-Iron Pipe.

McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
John Simmons Co., 110 Centre St., New York.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Cement Machinery.

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F. L. Smidth & Co., 39 Cortlandt St., New York.
E. H. Stroud & Co., Chicago, Ill.
Union Steam Pump Co., 44 So. Madison St., Battle Creek, Mich.
Vulcan Iron Works Co., Toledo, Ohio.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Cement—Portland.

American Cement Co., Philadelphia, Pa.
Atlas Portland Cement Co., 30 Broad St., N. Y.
Edison Portland Cement Co., Philadelphia, Pa.
Kelley Island Lime & Transport Co., Cleveland, O
Lawrence Cement Co., 1 Broadway, New York.

Chains.

Buhl Malleable Co., Detroit, Mich.
Morse Chain Co., Trumansburg, N. Y.

Chain Belting.

H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Jeffrey Manufacturing Co., Columbus, Ohio
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa

Chain Making Machinery (Welded Chain).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Checks, Time, Pay and Trade.

American Railway Supply Co., 24 Park Pl., N. Y.
Schwerdtle Stamp Co., Bridgeport, Conn.

Chemicals.

F. W. Braun Co., Los Angeles, Cal.
Roessler & Hasslacher Chem. Co., 100 William St., New York.

Chemists.

Chas. Catlett, Staunton, Va.
Robt. W. Hunt & Co., Chicago, Ill.

Chimneys, Steel.

W. J. Clark Co., Salem, Ohio.

Chucks.

American Tool & Machine Co., Boston, Mass.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Standard Tool Co., Cleveland, Ohio.

Clay-Working Machinery.

American Blower Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
E. H. Stroud & Co., Chicago, Ill.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.
Vulcan Iron Works, Toledo, Ohio.

Clocks, Tower and Office.

E. Howard Clock Co., 401 Washington St., Boston, Mass.

Clocks, Watchman.

E. Howard Clock Co., 401 Washington St., Boston, Mass.

Clothes Closets, Sheet Steel.

W. J. Clark Co., Salem, Ohio.

Clutch Pulleys.

H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.

Coal and Ashes-Handling Machinery.

Broderick & Bascom Rope Co., St. Louis, Mo.
Browning Engineering Co., Cleveland, O.
H. W. Caldwell & Sons Co., Chicago, Ill.
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C. W. Hunt Co., West New Brighton, New York.
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Ridgway Belt Conveyor Co., 29 Broadway, N. Y.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Frank B. Stratford, 95 Liberty St., New York.

Coal-Mining Machinery.

Allis-Chalmers Co., Chicago, Ill.
Broderick & Bascom Rope Co., St. Louis, Mo.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
General Electric Co., New York.
C. W. Hunt Co., West New Brighton, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Manufacturing Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 128 Broadway, New York.
Ridgway Belt Conveyor Co., 29 Broadway, N. Y.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Triumph Electric Co., Cincinnati, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Coal Screens.

Allis-Chalmers Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
W. S. Tyler Co., Cleveland, Ohio.

Coke Oven Machinery.

Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Cold Saw Cutting-off Machines.

Diamond Drill & Machine Co., Birdsboro, Pa.
Railway Appliances Co., Chicago, Ill.

Concentrators.

P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.

Concrete Mixers.

Contractors' Supply & Equipment Co., Chicago, Ill.
W. D. Dunning, Syracuse, N. Y.

Condensers.

Alberger Condenser Co., 95 Liberty St., New York.
Allis-Chalmers Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Guild & Garrison, Brooklyn, N. Y.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
John H. McGowan Co., Cincinnati, Ohio.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Struthers-Wells Co., Warren, Pa.
Union Steam Pump Co., 44 So. Madison St., Battle Creek, Mich.
Wheeler Condenser & Engineering Co., 42 Broadway, New York.
Henry R. Worthington, 118 Liberty St., New York

Conduits.

American Conduit Co., 336 Macy St., Los Angeles, Cal.

Contractors' Cars.

Continental Car & Equipment Co., Whitehall Bldg., New York.

Contractors' Elevators.

American Hoist & Derrick Co., St. Paul, Minn.

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Contractors' Supplies.
A. Leschen & Sons Rope Co., St. Louis, Mo.

Controllers.
The Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Power & Speed Controller Co., Boston, Mass.

Conveying Machinery.
Broderick & Bascom Rope Co., St. Louis, Mo.
Browning Engineering Co., Cleveland, O.
Buhl Malleable Co., Detroit, Mich.
H. W. Caldwell & Sons Co., Chicago, Ill.
Frick Company, Waynesboro Pa.
Hayward Co., 97 Cedar St., New York.
C. W. Hunt Co., West New Brighton, New York.
Interstate Engineering Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
A. Leschen & Sons Pope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Ridgway Belt Conveyor Co., 29 B'way, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Russel Wheel & Foundry Co., Detroit, Mich.
Trenton Iron Co., Trenton, N. J.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Cooling Towers.
Alberger Condenser Co., 95 Liberty St., New York.
Wheeler Condenser & Engineering Co., 42 Broadway, New York.
Henry R. Worthington, New York City.

Copper.
Orford Copper Co., 74 Broadway, New York.

Cornices.
G. Drouvé & Co., Bridgeport, Conn.

Corn Oil Machinery.
Hanna Eng'ng Works, 820 Elston Av., Chicago, Ill.

Cost Systems.
Baker-Vawter Co., Chicago, Ill.
Cost-System & Auditing Co., 45 B'way, New York.
Hugo Diemer, Lawrence, Kansas.
Gunn & Richards, 41 Wall St., New York.
Miller & Franklin, 319 Washington St., Boston, Mass.
David Townsend, 624 Witherspoon Bldg., Phila., Pa.

Cotton Oil Machinery.
Hanna Eng'ng Works, 820 Elston Ave., Chicago, Ill.
Union Steam Pump Co., 44 So. Madison St., Battle Creek, Mich.

Couplings, Fire Hose.
W. J. Clark Co., Salem, Ohio.

Crane Motors.
Northern Electrical Mfg. Co., Madison, Wis.

Cranes.
American Hoist & Derrick Co., St. Paul, Minn.
Browning Engineering Co., Cleveland, Ohio.
Case Mfg. Co., Columbus, Ohio.
Hayward Co., 97 Cedar St., New York.
Industrial Works, Bay City, Mich.
Interstate Engineering Co., Cleveland, Ohio.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Shaw Electric Crane Co., Muskegon, Mich.
Frank B. Stratford, 95 Liberty St., New York.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Crucibles.
F. W. Braun Co., Los Angeles, Cal.
Jos. Dixon Crucible Co., Jersey City, N. Y.
J. D. Smith Fdy. Supply Co., Cleveland, O.

Crushers—Ore, Phosphate, Rock.
Allis-Chalmers Co., Chicago, Ill.
F. W. Braun Co., Los Angeles, Cal.
Diamond Drill & Machine Co., Birdsboro, Pa.
F. L. Smidth & Co., 39 Cortlandt St., New York.
E. H. Stroud & Co., Chicago, Ill.
Sturtevant Mill Co., Boston, Mass.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Crusher Rings and Shells (Steel).
Latrobe Steel Co., Philadelphia, Pa.

Cupel Machines.
F. W. Braun Co., Los Angeles, Cal

Cupolas.
J. D. Smith Fdy. Supply Co., Cleveland, O.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Cutters, Milling.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Standard Tool Co., Cleveland, Ohio.

Derricks.
American Hoist & Derrick Co., St. Paul, Minn.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Frank B. Stratford, 95 Liberty St., New York.

Derrick Fittings.
American Hoist & Derrick Co., St. Paul, Minn.
Contractors' Plant Mfg. Co., Buffalo, N. Y.

Diamond Drills.
American Diamond Rock Drill Co., 95 Liberty St., New York.
Standard Diamond Drill Co., Chicago, Ill.

Digesters.
Atlantic Works, East Boston, Mass.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Tippett & Wood, Phillipsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.

Draught Gauges.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Draftsmen's Instruments and Materials.
Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Buff & Buff Mfg. Co., J. Plain Sta., Boston, Mass.
Eugene Dietzgen Co., 181 Monroe St., Chicago, Ill.
Keuffel & Esser Co., 127 Fulton St., New York.
Kolesch & Co., 138 Fulton St., New York.
Universal Drafting Machine Co., 220 Seneca St., Cleveland, Ohio.

Dredges—SEE EXCAVATORS.

Drilling Machines.
American Tool Works Co., Cincinnati, Ohio.
W. F. & John Barnes Co., Rockford, Ill.
Jas. Clark, Jr., & Co., Louisville, Ky.
Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Cleveland Punch & Shear Works, Cleveland, Ohio.
Thos. H. Dallett & Co., Philadelphia, Pa.
Diamond Drill & Machine Co., Birdsboro, Pa.
Hoefer Mfg. Co., 100 Chicago St., Freeport, Ill.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drills—Rock and Coal.
American Diamond Rock Drill Co., 95 Liberty St., New York.
Clayton Air Compress Wks., 120 Liberty St., N. Y.
Davis Calyx Drill Co., 128 Broadway, New York.
Hall Steam Pump Co., Pittsburg, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 128 Broadway, New York.
Standard Diamond Drill Co., 108 La Salle St., Chicago, Ill.

Drop Forgings.
Globe Machine & Stamping Co., Cleveland, Ohio.

Drying and Calcining Machines.
American Engine Co., Bound Brook, N. J.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Boston, Mass.

Dump Cars.
Continental Car & Equipment Co., Whitehall Bldg., New York.
Russel Wheel & Foundry Co., Detroit, Mich.

Dynamos.
American Engine Co., Bound Brook, N. J.
Bullock Electric Mfg. Co., Cincinnati, Ohio.

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Crocker-Wheeler Co., Ampere, N. J.
C & C Electric Co., 143 Liberty St., New York.
Guarantee Electric Co., Chicago, Ill.
General Electric Co., New York.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Northern Electrical Mfg. Co., Madison, Wis.
Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Ejectors.

Hancock Inspirator Co., 85 Liberty St., New York.
Hayden & Derby Mfg. Co., New York.
Watson & McDaniel Co., Philadelphia, Pa.

Electric Hoists.

American Hoist & Derrick Co., St. Paul, Minn.
Browning Engineering Co., Cleveland, O.
C & C Electric Co., New York, N. Y.
C. W. Hunt Co., West New Brighton, N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Shaw Electric Crane Co., Muskegon, Mich.
Sprague Electric Co., 527-531 W. 34th St., N. Y.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Electric Heating Apparatus.

Simplex Electric Heating Co., Cambridgeport, Mass.

Electrical Machinery and Supplies.

Bristol Co., Waterbury, Conn.
Bullock Electric Mfg. Co., Cincinnati, Ohio.
C & C Electric Co., 143 Liberty St., New York.
Crocker-Wheeler Co., Ampere, N. J.
The Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Kenworthy Engineering & Construction Co., Waterbury, Conn.
Northern Electrical Mfg. Co., Madison, Wis.
The Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.

Elevators.

American Tool & Machine Co., Boston, Mass.
Buhl Malleable Co., Detroit, Mich.
H. W. Caldwell & Sons Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Morse Elevator Works, Philadelphia, Pa.
Poole Engineering & Machine Co., Baltimore, Md.
Triumph Electric Co., Cincinnati, Ohio.

Elevator Buckets.

W. J. Clark Co., Salem, Ohio.

Emery Wheel Dressers

Globe Machine & Stamping Co., Cleveland, Ohio.

Emery Wheels.

Carborundum Co., Niagara Falls, N. Y.
Frank Machinery Co., Buffalo, N. Y.
Stow Flexible Shaft Co., Philadelphia, Pa.

Employment Bureau.

Engineering Agency, Monadnock Blk., Chicago, Ill.

Engineering Instruments.

Theo. Altenedер & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Buff & Buff Mfg. Co., Boston, Mas
Eugene Dietzgen Co., Chicago, Ill.
Keuffel & Esser Co., New York City.
Kolesch & Co., 138 Fulton St., New York.

Engineers, Civil.

Engineering Co. of America, 74 B'way, New York.
Hudson Engineering & Contracting Co., 92 William St., New York.
Robert W. Hunt & Co., 1121 The Rookery, Chicago, Ill.
Chas. C. Moore & Co., San Francisco, Cal.
A. W. Robinson, Montreal, Canada.

Engineers, Electrical.

Crocker-Wheeler Co., Ampere, N. J.
Abner Doble Co., Fremont & Howard Sts., San Francisco, Cal.
Dodge & Day, Nicetown, Phila., Pa.
Electric Controller & Supply Co., Cleveland, O.
Engineering Co. of America, 74 B'way, New York.
W. K. Palmer, 718 Dwight Bldg., Kansas City, Mo.
Power Installation Co., Buffalo, N. Y.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Station A, Chicago, Ill.
Moran Bros., Seattle, Wash.
Vulcan Iron Works Co., Toledo, Ohio.

Engineers, Mechanical.

William M. Brewer, Vancouver, B. C.
Geo. M. Brill, Marquette Bldg., Chicago, Ill.
Edward S. Cobb., Los Angeles, Cal.
Hugo Diemer, Lawrence, Kans.
Abner Doble Co., Fremont & Howard Sts., San Francisco, Cal.
Dodge & Day, Nicetown, Phila., Pa.
Engineering Co. of America, 74 B'way, New York.
Holt & Schober, 378 Bourse, Philadelphia, Pa.
Julian Kennedy, Pittsburg, Pa.
Walter Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Pittsburg, Pa.
Milton L. Oglesby, David Keith Bldg., Salt Lake City, Utah.
W. K. Palmer, 718 Dwight Bldg., Kansas City, Mo.
Power Installation Co., Buffalo, N. Y.
A. W. Robinson, Montreal, Canada.
H. B. Roelker, 41 Maiden Lane, New York.
David Townsend, 624 Witherspoon Bldg., Phila., Pa.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Engineers, Mining.

William M. Brewer, Vancouver, B. C.
Chas. Catlett, Staunton, Va.
Engineering Co. of America, 74 B'way, New York.
Henshaw, Bulkley & Co., San Francisco, Cal.
Milton L. Oglesby, David Keith Bldg., Salt Lake City, Utah.

Engines, Blowing.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Southwark Foundry & Machine Co., Phila., Pa.
Sprague Electric Co., 527 W. 34th St., New York.
Wm. Tod Co., Youngstown, O.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Engines—Gas, Gasoline, and Petroleum.

American Well Works, Aurora, Ill.
Foos Gas Engine Co., Springfield, Ohio.
J. D. Lyon & Co., Pittsburg, Pa.
Struthers-Wells Company, Warren, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engines, Horse and Hand Power.

Contractors' Plant Mfg. Co., Buffalo, N. Y.

Engines, Steam.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
American Engine Co., Bound Brook, N. J
American Well Works, Aurora, Ill.
Atlas Engine Works., Indianapolis, Ind.
Ball Engine Co., Erie, Pa.
A. F. Bartlett & Co., Saginaw, Mich.
Bradley Mfg. Co., Allegheny, Pa.
Brown Corliss Engine Co., Corliss, Wis.
Contractors' Supply & Equipment Co., Chicago, Ill.
Frick Company, Waynesboro, Pa.
Harrisburg Foundry & Machine Co., Harrisburg, Pa.
Hooven, Owens, Rentschler Co., Hamilton, Ohio.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Providence Engineering Works, Providence, R. I.
Quincy Engine Works, Quincy, Ill.
Reeves Engine Co., 85 Liberty St., New York.
Rider-Ericsson Engine Co., New York City.
Rotary Engine Co., Philadelphia, Pa.

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Southwark Foundry & Machine Co., Phila., Pa.
Struthers-Wells Company, Warren, Pa.
B. F. Sturtevant Co., Boston, Mass.
The William Tod Co., Youngstown, Ohio.
Vulcan Iron Works, San Francisco, Cal.
Webster, Camp & Lane Machine Co., Cleveland, O.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Evaporators.

Wheeler Condenser & Engineering Co., 42 Broadway, New York.

Excavators.

American Hoist & Derrick Co., St. Paul, Minn.
Atlantic, Gulf & Pacific Co., Park Row Bldg., N. Y.
Broderick & Bascom Rope Co., St. Louis, Mo.
Bucyrus Co., So. Milwaukee, Wis.
Cyclopean Iron Works, 402 Claremont Ave., Jersey City, N. J.
The Hayward Co., 97 Cedar St., New York.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Marion Steam Shovel Co., Marion, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Frank B. Stratford, 95 Liberty St., New York.
Vulcan Iron Works, Toledo, Ohio.

Exhaust Heads.

Direct Separator Co., Syracuse, N. Y.
Hoppes Mfg. Co., Springfield, Ohio.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
B. F. Sturtevant Co., Boston Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wright Mfg. Co., Detroit, Mich.

Expanded Metal.

Associated Expanded Metal Cos., 256 B'way, N. Y.

Expansion Bolts.

Isaac Church, Toledo, Ohio.

Fans, Ventilating.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Power Specialty Co., 126 Liberty St., New York.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Boston, Mass.

Feed-Water Heaters and Purifiers.

Allis-Chalmers Co., Chicago, Ill.
G. M. Davis Regulator Co., 141 Milwaukee Ave., Chicago, Ill.
Goubert Mfg. Co., 85 Liberty St., New York.
Green Fuel Economizer Co., Matteawan, N. Y.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Providence Engineering Works, Providence, R. I.
Ross Valve Co., Troy, N. Y.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Warren Webster & Co., Camden, N. J.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Engineering Co., 42 Broadway, New York.

Fertilizer Machinery.

Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
E. H. Stroud & Co., Chicago, Ill.

Files and Rasps.

G. & H. Barnett Co., Philadelphia, Pa.
Nicholson File Co., Providence, R. I.

Filters.

L. O. Koven & Bro., New York City.
New York Cont. Jewell Filt. Co., 15 Broad St., N. Y.
Ross Valve Co., Troy, N. Y.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.

Fire Brick.

Henry Maurer & Son, 420 East 23d St., New York.
National Pyrogranit Co., 17 Battery Place, N. Y.
J. D. Smith Fdy. Supply Co., Cleveland, O.

Fireproof Building Materials.

Associated Expanded Metal Cos., 256 B'way, N. Y.
Clinton Fireproofing System, 150 Nassau St., N. Y.
Henry Maurer & Son., 420 East 23d St., New York.
National Fireproofing Co., Pittsburg, Pa.
Roebling Construction Co., 121 Liberty St., N. Y.

Fireproof Frames.

Josephus Plenty, Jersey City, N. J.

Flanges.

E. M. Dart Mfg. Co., 136 Clifford St., Providence, R. I.
Latrobe Steel Co., 1200 Girard Bldg., Phila., Pa.

Flanges (Weldless Steel).

Latrobe Steel Co., 1200 Girard Bldg., Phila., Pa.

Flexible Shafts.

Chicago Flexible Shaft Co., 154 La Salle St., Chicago, Ill.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Float Valves.

Foster Engineering Co., Newark, N. J.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flue Cleaners.

Michigan Lubricator Co., Detroit, Mich.

Fly Wheels.

Allis-Chalmers Co., Chicago, Ill.
Poole Engineering & Machine Co., Baltimore, Md.
Quincy Engine Works, Quincy, Ill.
Robt. Wetherill & Co., Chester, Pa.

Forges.

B. F. Sturtevant Co., Boston, Mass.

Forgings, Iron and Steel.

Chester B. Albree, Allegheny, Pa.
Vulcan Iron Works Co., Toledo, Ohio.
Wyman & Gordon, Worcester, Mass.

Foundry Equipment.

Blanchard Machine Co., Boston, Mass.
Buffalo Foundry Co., Buffalo, N. Y.
Coburn Trolley Track Mfg. Co., Holyoke, Mass.
Diamond Drill & Machine Co., Birdsboro, Pa.
A. Garrison Foundry Co., Pittsburg, Pa.
C. W. Hunt Co., West New Brighton, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Arthur Koppel, 68 Broad St., New York.
J. W. Paxson Co., Philadelphia, Pa.
Shaw Electric Crane Co., Muskegon, Mich.
J. D. Smith Fdy. Supply Co., Cleveland, O.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Foundry Ladle Cars.

Russel Wheel & Foundry Co., Detroit, Mich.

Friction Clutches.

American Tool & Machine Co., Boston, Mass.
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Link Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Poole Engineering & Machine Co., Baltimore, Md.

Fuel Economizers.

Green Fuel Economizer Co., Matteawan, N. Y.
Kenworthy Engineering & Construction Co., Waterbury, Conn.
Parson Mfg. Co., 320 Broadway, New York.
Providence Engineering Works, Providence, R. I.
E. H. Stroud & Co., Chicago, Ill.
B. F. Sturtevant Co., Boston, Mass.

Furnace Builders.

American Gas Furnace Co., 23 John St., New York.
Continental Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Chicago Flexible Shaft Co., 154 La Salle St., Chicago, Ill.
Julian Kennedy, Pittsburg, Pa.
Kenworthy Engineering & Construction Co., Waterbury, Conn.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.

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Parson Mfg. Co., 320 Broadway, New York.
Wm. B. Pollock Co., Youngstown, Ohio.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Furnaces, Metallurgists.

F. W. Braun Co., Los Angeles, Cal.
Kenworthy Eng'g & Construction Co., Waterbury, Conn.

Gages—Pressure, Steam, Water, etc.

American Steam Gauge & Valve Co., Boston, Mass.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Ashton Valve Co., Boston, Mass.
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.
Kenworthy Engineering & Construction Co., Waterbury, Conn.
Michigan Lubricator Co., Detroit, Mich.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
John Simmons Co., 110 Centre St., New York.
Standard Gauge Mfg. Co., Syracuse, N. Y.
Star Brass Mfg. Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.

Galvanizing.

L. O. Koven & Bro., New York City.
John Simmons Co., 110 Centre St., New York.

Galvanizing Machinery and Furnaces (Wire).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Gas Holders and Regulators.

Continental Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Gaskets.

Boston Belting Co., Boston, Mass.
U. S. Mineral Wool Co., 143 Liberty St., New York.

Gas Machines and Generators.

American Gas Furnace Co., 23 John St., New York.
Chicago Flexible Shaft Co., 154 La Salle St., Chicago, Ill.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Morgan Construction Co., Worcester, Mass.
Power & Mining Machinery Co., 52 William St., New York.
R. D. Wood & Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Gear Cutting Machines.

Becker-Brainard Milling Machine Co., Hyde Park, Mass.

Gearing.

Allis-Chalmers Co., Chicago, Ill.
Hugo Bilgram, 440 No. 12th St., Philadelphia, Pa.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Boston Gear Works, Boston, Mass.
Buhl Malleable Co., Detroit, Mich.
H. W. Caldwell & Son Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Dayton Globe Iron Works Co., Dayton, O.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Morse Elevator Works, Philadelphia, Pa.
New Process Rawhide Co., Syracuse, N. Y.
R. D. Nuttall Co., Pittsburg, Pa.
Poole Engineering & Machine Co., Baltimore, Md.
Stow Flexible Shaft Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Pa.

Glass Oilers.

Michigan Lubricator Co., Detroit, Mich.

Grain Elevator Machinery.

Allis-Chalmers Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Graphite.

Jos. Dixon Crucible Co., Jersey City, N. J.
J. D. Smith Fdy. Supply Co., Cleveland, O.

Grease Cups.

Michigan Lubricator Co., Detroit, Mich.

Grease Separators.

Loew Supply & Mfg. Co., Cleveland, Ohio.

Grinders, Electric.

Northern Electrical Mfg. Co., Madison, Wis

Grinding and Polishing Machinery.

American Tool Works Co., Cincinnati, Ohio.
Diamond Machine Co., Providence, R. I.
Landis Tool Co., Waynesboro, Pa.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.
F. L. Smidth & Co., 39 Cortlandt St., New York.
Stow Flexible Shaft Co., Philadelphia, Pa.

Hangers—SEE PULLEYS.

Heading and Upsetting Machines.

National Machinery Co., Tiffin, Ohio.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Hayden & Derby Mfg. Co., New York.
Josephus Plenty, Jersey City, N. J.
Railway Appliances Co. Old Colony Bldg., Chicago, Ill.
John Simmons Co., 110 Centre St., New York.
Sprague Electric Co., 527 W. 34th St., New York.
H. B. Smith Co., 137 Centre St., New York.
B. F. Sturtevant Co., Boston, Mass.
Walworth Mfg. Co., Boston, Mass.

Hoisting Buckets.

Cyclopean Iron Works, 402 Claremont Ave., Jersey City, N. J.
G. L. Steubner Iron Works, Long Island City, N. Y.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Hoisting Engines and Machinery.

Allis-Chalmers Co., Chicago, Ill.
American Hoist & Derrick Co., St. Paul, Minn.
A. F. Bartlett & Co., Saginaw, Mich.
Brown Hoisting Machinery Co., 26 Cortlandt St. New York.
Browning Engineering Co., Cleveland, Ohio.
Buhl Malleable Co., Detroit, Mich.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Contractors' Supply & Equipment Co., Chicago, Ill.
Cyclopean Iron Works, 402 Claremont Ave., Jersey City, N. J.
General Pneumatic Tool Co., Montour Falls, N. Y.
The Hayward Co., 97 Cedar St., New York.
C. W. Hunt Co., West New Brighton, New York.
Industrial Works, Bay City, Mich.
Interstate Engineering Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
Niles Tool Works Co., Hamilton, Ohio.
Providence Engineering Works, Providence, R. I.
Quincy Engine Works, Quincy, Ill.
Frank B. Stratford, 95 Liberty St., New York.
Sprague Electric Co., 527-531 W. 34th St., N. Y.
G. L. Stuebner Iron Works, Long Island City, N. Y.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Works Co., Toledo, Ohio.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Hollow Chisel Mortisers.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Frank Machinery Co., Buffalo, N. Y.

Hose.

Boston Belting Co., Boston, Mass.
Eureka Fire Hose Co., New York City.

Hose Couplings, Air and Water.

W. J. Clark Co., Salem, Ohio.

Hydraulic Machinery.

Detroit Leather Specialty Co., Detroit, Mich.
Hanna Eng'ng Works, 820 Elston Ave., Chicago, Ill.
John H. McGowan Co., Cincinnati, Ohio.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pelton Water Wheel Co., San Francisco, Cal.
Poole Engineering & Machine Co., Baltimore, Md.
Power Specialty Co., 126 Liberty St., New York.
Union Steam Pump Co., 44 So. Madison St., Battle Creek, Mich.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

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Watson-Stillman Co., 46 Dey St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Rams.

Pelton Water Wheel Co., San Francisco, Cal.
Power Specialty Co., 126 Liberty St., New York.

Ice-Making and Refrigerating Machinery.

Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Frick Company, Waynesboro, Pa.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
H. B. Roelker, 41 Maiden Lane, New York.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Vulcan Iron Works, San Francisco, Cal.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Westinghouse Machine Co., Pittsburg, Pa.
Henry R. Worthington, 118 Liberty St., New York.

Injectors.

Hayden & Derby Mfg. Co., New York.
John Simmons Co., 110 Centre St., New York.

Industrial Railways.

Russel Wheel & Foundry Co., Detroit, Mich.

Instruments, Scientific and Mathemattcal.

Kolesch & Co., 138 Fulton St., New York.

Insulated Wire.

General Electric Co., New York.
Sprague Electric Co., 527 W. 34th St., New York.

Insulating Materials.

Sterling Varnish Co., Pittsburg, Pa.

Internal Gearing.

R. D. Nuttall Co., Pittsburg, Pa.

Iron and Bronze, Ornamental.

W. S. Tyler Co., Cleveland, Ohio.

Jacks, Hydraulic.

Watson-Stillman Co., 46 Dey St., New York.

Kiers.

Atlantic Works, East Boston, Mass.

Laboratory Supplies.

F. W. Braun Co., Los Angeles, Cal.

Lamps, Electric.

General Electric Co., New York.
Sterling Electrical Mfg. Co., Warren, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.

American Tool & Machine Co., Boston, Mass.
American Tool Works Co., Cincinnati, Ohio.
W. F. & John Barnes Co., Rockford, Ill.
Bullard Machine Tool Co., Box 1055, Bridgeport, Conn.
Diamond Machine Co., Providence, R. I.
Fay & Scott, Dexter, Me.
A. Garrison Foundry Co., Pittsburg, Pa.
Jones & Lamson Machine Co., Springfield, Vt.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.
bury, Conn.
Waterbury Farrel Foundry & Machine Co., Water-

Leather, Hydraulic, Valve and Pump.

Detroit Leather Specialty Co., Detroit, Mich.

Lifting Magnets.

Electric Controller & Supply Co., Cleveland, Ohio.

Light Railways.

C. W. Hunt Co., West New Brighton, New York.
Arthur Koppel, 68 Broad St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
G. L. Stuebner Iron Works, Long Island City, N. Y.

Lockers.—Metal.

Lyon Metallic Mfg. Co., 18 So. Ann St., Chicago, Ill.
Merritt & Co., Philadelphia, Pa.

Locomotive Cranes.

American Hoist & Derrick Co., St. Paul, Minn.
Browning Engineering Co., Cleveland, Ohio.
Industrial Works, Bay City, Mich.
Interstate Engineering Co., Cleveland, Ohio.
Frank B. Stratford, 95 Liberty St., New York.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Locomotives, Compressed Air.

Baldwin Locomotive Works, Phila, Pa.
H. K. Porter Co., Pittsburg, Pa.

Locomotives, Electric.

Baldwin Locomotive Works, Philadelphia, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
C. W. Hunt Co., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
H. K. Porter Co., Pittsburg, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Locomotives, Steam.

American Locomotive Co., 25 Broad St., New York.
Baldwin Locomotive Works, Philadelphia, Pa.
Contractors' Supply & Equipment Co., Chicago, Ill.
H. K. Porter Co., Pittsburg, Pa.
Rogers Locomotive Works, Paterson, N. J.

Logging Cars.

Russel Wheel & Foundry Co., Detroit, Mich

Linseed Oil Machinery.

Hanna Eng'ng Works, 820 Elston Ave., Chicago, Ill.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricating and Oiling Devices.

E. M. Dart Mfg. Co., 136 Clifford St., Providence, R. I.
Michigan Lubricator Co., Detroit, Mich.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Lubricators.

Michigan Lubricator Co., Detroit, Mich.

Machinery Exhibit.

Bourse, Philadelphia, Pa.

Machine Shop Furniture.

Lyon Metallic Mfg. Co., 18 S. Ann St., Chicago, Ill.

Machinists' Small Tools.

Thomas H. Dallett Co., York St. & Sedgley Ave., Philadelphia, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, Ohio.

Marine Engines.

Marine Iron Works, Station A, Chicago, Ill.

Meters, Electric.

General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.

Milling Machines.

Adams Company, Dubuque, Iowa.
American Tool & Machine Co., Boston, Mass.
American Tool Works Co., Cincinnati, Ohio.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bullard Machine Tool Co., Bridgeport, Conn.
Henshaw, Bulkley & Co., San Francisco, Cal.
Hess-Bright Co., 15th and Chestnut Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.

Mill Supplies.

Phillips Mine & Mill Supply Co., Pittsburg, Pa.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Mine Cars.

Allis-Chalmers Co., Chicago.
C. W. Hunt Co., West New Brighton, N. Y.
Jeffrey Manufacturing Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Mining Machinery.

Allis-Chalmers Co., Chicago, Ill.
American Diamond Rock Drill Co., 95 Liberty St., New York.

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A. F. Bartlett & Co., Saginaw, Mich.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Broderick & Bascom Rope Co., St. Louis, Mo.
Buhl Malleable Co., Detroit, Mich.
Contractors' Supply & Equipment Co., Chicago, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Diamond Drill & Machine Co., Birdsboro, Pa.
General Electric Co., New York.
Henshaw, Bulkley & Co., San Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Marion Steam Shovel Co., Marion, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Phillips Mine & Mill Supply Co., Pittsburg, Pa.
Power & Mining Machinery Co., 52 William St., New York.
Power Specialty Co., 126 Liberty St., New York.
Providence Engineering Works, Providence, R. I.
Quincy Engine Works, Quincy, Ill.
Rand Drill Co., 128 Broadway, New York.
Ridgway Belt Conveyor Co., 29 Broadway, N. Y.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 39 Cortlandt St., New York.
Snow Steam Pump Works, 116 Liberty St., N. Y.
E. H. Stroud & Co., Chicago, Ill.
Trenton Iron Works Co., Trenton, N. J.
Union Steam Pump Co., 44 So. Madison St., Battle Creek, Mich.
Vulcan Iron Works, San Francisco, Cal.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.
Henry R. Worthington, 118 Liberty St., New York.

Mining Screens—SEE SCREENS.

Motors, Electric.

American Engine Co., Bound Brook, N. J.
Bullock Electric Mfg. Co., Cincinnati, Ohio.
C & C Electric Co., 145 Liberty St., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Guarantee Electric Co., Chicago, Ill.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Northern Electrical Mfg. Co., Madison, Wis.
The Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
Stow Mfg. Co., Binghamton, N. Y.
B. F. Sturtevant Co., Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Moulding Machines.

Frank Machinery Co., Buffalo, N. Y.
J. W. Paxson Co., Philadelphia, Pa.
Power Specialty Co., 126 Liberty St., New York.
J. D. Smith Fdy. Supply Co., Cleveland, O.
Tabor Mfg. Co., Philadelphia, Pa.

Muffles and Annealing Furnaces (Wire).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Name Plates and Labels.

American Railway Supply Co., 24 Park Place, N. Y.
Schwerdtle Stamp Co., Bridgeport, Conn.

Naphtha Gas Machines.

American Gas Furnace Co., 23 John St., New York.

Narrow Gauge Cars.

G. L. Stuebner Iron Works, Long Island City, N. Y.

Nickel.

Benedict & Burnham Mfg. Co., Waterbury, Conn.
Orford Copper Co., 74 Broadway, New York.

Nozzles.

Abner Doble Co., Fremont & Howard Sts., San Francisco, Cal.

Nozzle and Sleeve Press.

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Nut Tappers.

National Machinery Co., Tiffin, Ohio.

Office Equipment.

Baker-Vawter Co., Chicago, Ill.
Globe-Wernicke Co., Cincinnati, Ohio.

Oil Burners.

C. A. Hammel, 120 W. Fifth St., Los Angeles, Cal.

Oil Filters.

Loew Supply & Mfg. Co., Cleveland, Ohio.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Oil Pumps.

Michigan Lubricator Co., Detroit, Mich.

Oil Separators.

American Tool & Machine Co., Boston, Mass.
Austin Separator Co., Detroit, Mich.
Harrison Safety Boiler Works, 3138 No. Seventeenth St., Philadelphia, Pa.
Loew Supply & Mfg. Co., Cleveland, Ohio.

Oiling Systems.

Pittsburg Gage & Supply Co., Pittsburg, Pa.

Open Hearth Furnaces.

G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.

Package Carriers.

Lamson Consolidated Store Service Co., Boston-Mass.

Packing.

Boston Belting Co., Boston, Mass.
Broderick & Bascom Rope Co., St. Louis, Mo.
Detroit Leather Specialty Co., Detroit, Mich.
Jenkins Brothers, 71 John St., New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.

Paints and Varnishes.

Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
Paraffine Paint Co., San Francisco, Cal.
Standard Paint Co., 100 William St., New York.
Sterling Varnish Co., Pittsburg, Pa.

Paper-Mill Machinery.

Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Henry R. Worthington, 118 Liberty St., New York.

Patent Attorneys.

C. A. Dieterich, 257 Broadway, New York.
Goepel & Niles, 290 Broadway, New York.
Edward M. Weeks, 705 McGill Bldg., Washington, D. C.
Evans, Wilkins & Co., Evans Building, Washington, D. C.

Pattern-Makers' Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Fay & Scott, Dexter, Me.
Frank Machinery Co., Buffalo, N. Y.
Pratt & Whitney Co., Hartford, Conn.
J. D. Smith Fdy. Supply Co., Cleveland, O.

Pattern Makers.

Buhl Malleable Co., Detroit, Mich.
Diamond Drill & Machine Co., Birdsboro, Pa.

Pavement.

Warren Bros. Co., 253 Broadway, New York.

Perforated Metal.

Allis-Chalmers Co., Chicago, Ill.
H. W. Caldwell & Sons Co., Chicago, Ill.
Hendrick Mfg. Co., Carbondale, Pa.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Phosphor Bronze.

Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
Poole Engineering & Machine Co., Baltimore, Md.
Paul S. Reeves & Son., Philadelphia, Pa.

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Pick-Up Carriers.

Lamson Consolidated Store Service Co., Boston, Mass.

Pile Drivers.

American Hoist & Derrick Co., St. Paul, Minn.
Bucyrus Co., So. Milwaukee, Wis.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Interstate Engineering Co., Cleveland, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.

Pinions.

A. Garrison Foundry Co., Pittsburg, Pa.

Pipe.

American Spiral Pipe Works, Chicago, Ill.
W. J. Clark Co., Salem, Ohio.
L. O. Koven & Bro., 50 Cliff St., New York.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Pelton Water Wheel Co., San Francisco, Cal.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa.

Pipe-Cutting and Threading Machines.

Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Cox & Sons Company, Bridgeton, N. J.
Curtis & Curtis Co., Bridgeport, Conn.
Howard Iron Works, Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast-Iron.

American Spiral Pipe Works, Chicago, Ill.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Pelton Water Wheel Co., San Francisco, Cal.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.

Pipe Vises.

John Simmons Co., 110 Centre St., New York.

Piston Rods.

B. M. Jones & Co., 159 Devonshire St., Boston, Mass.

Planers.

American Tool Works Co., Cincinnati, Ohio.
Cleveland Punch & Shear Works, Cleveland, Ohio
Frank Machinery Co., Buffalo, N. Y.
Hilles & Jones Co., Wilmington, Del.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.

Planing Mill Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Frank Machinery Co., Buffalo, N. Y.

Platinum Ware.

F. W. Braun Co., Los Angeles, Cal.

Pneumatic Tools.

Clayton Air Compress. Wks., 114 Liberty St., N. Y.
Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Thos. H. Dallett & Co., Philadelphia, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
E. W. Irwin Machinery & Supply Co., 114 Liberty St., New York.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Railway Appliances Co. Old Colony Bldg., Chicago, Ill.
Rand Drill Co., 128 Broadway, New York.

Pneumatic Tubes.

Lamson Consolidated Store Service Co., Boston, Mass.

Pop Safety Valves.

American Steam Gauge & Valve Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Consolidated Safety Valve Co., 85-89 Liberty St., New York.
Crosby Steam Gage & Valve Co., Boston, Mass.
Star Brass Mfg. Co., Boston, Mass.

Portable Drilling Machines.

Thos. H. Dallett & Co., Philadelphia, Pa.

Power Hammers.

Pratt & Whitney Co., Hartford, Conn.

Power Machinery, Steam, Gas or Water.

Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Power-Transmission Machinery.

Allis-Chalmers Co., Chicago, Ill.
Broderick & Bascom Rope Co., St. Louis, Mo.
Buhl Malleable Co., Detroit, Mich.
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Dayton Globe Iron Works Co., Dayton, O.
General Electric Co., New York.
Hayward Co., 97 Cedar St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Quincy Engine Works, Quincy, Ill.
Ridgway Belt Conveyor Co., 29 B'way, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Sprague Electric Co., 527 W. 34th St., New York.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Presses and Dies.

The Curtis & Curtis Co., Bridgeport, Conn.
Niagara Machine & Tool Works, Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Watson-Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Pressure Regulators—Steam, Water and Air.

Julian D'Este Company, 24 Canal St., Boston, Mass.
Foster Engineering Co., Newark, N. J.

Production Engineers.

Gunn, Richards & Co., 41 Wall St., New York.
Miller & Franklin, 319 Washington St., Boston, Mass.

Prospecting Drills.

American Diamond Rock Drill Co., 95 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.

Pulleys, Shafting and Hangers.

Allis-Chalmers Co., Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
Buhl Malleable Co., Detroit, Mich.
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
W. J. Clark Co., Salem, Ohio.
Fay & Egan, 212-232 W. Front St., Cincinnati, O.
Frank Machinery Co., Buffalo, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Niles Tool Works Co., New York, N. Y.
Poole Engineering & Machine Co., Baltimore, Md.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Pump Governors.

Foster Engineering Co., Newark, N. J.

Pulverizers.

F. W. Braun Co., Los Angeles, Cal.
E. H. Stroud & Co., 30-36 La Salle St., Chicago, Ill.

Pumps and Pumping Machinery.

Alberger Condenser Co., 95 Liberty St., New York.
Allis-Chalmers Co., Chicago, Ill.
American Well Works, Aurora, Ill.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Bacon Air Lift Co., 92 William St., New York.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Bucyrus Co., So. Milwaukee, Wis.
Buhl Malleable Co., Detroit, Mich.
Clayton Air Compress. Wks., 114 Liberty St., N. Y.
G. M. Davis Regulator Co., 141 Milwaukee Ave., Chicago, Ill.
The Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Epping-Carpenter Co., Pittsburg, Pa.
Flint & Walling Mfg. Co., Kendallville, Ind
Guild & Garrison, Brooklyn, N. Y.
Hall Steam Pump Co., Pittsburg, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.

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Kenworthy Engineering & Construction Co., Waterbury, Conn.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
The Laidlaw-Dunn-Gordon Co., 116 Liberty St., New York
John H. McGowan Co., Cincinnati, Ohio.
Morris Machine Works, Baldwinsville, N. Y.
Pneumatic Eng'g Co., 128 Broadway, N. Y.
Providence Engineering Works, Providence, R. I.
Quincy Engine Works, Quincy, Ill.
Rider-Ericsson Eng. Co., 35 Warren St., New York.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
William Tod Company, Youngstown, Ohio.
Union Steam Pump Co., 44 So. Madison St., Battle Creek, Mich.
Watson-Stillman Co., New York City.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Engineering Co., 42 Broadway, New York.
R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 118 Liberty St., New York.

Pump Valves.

Boston Belting Co., Boston, Mass.
Power Specialty Co., 126 Liberty St., New York.

Punches and Dies.

Globe Machine & Stamping Co., Cleveland, Ohio.

Punching and Shearing Machinery.

Bethlehem Fdry. & Mch. Co., So. Bethlehem, Pa.
Cleveland Punch & Shear Works, Cleveland, Ohio.
Hilles & Jones Co., Wilmington, Del.
A. Garrison Foundry Co., Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
The National Machinery Co., Tiffin, O.
Niagara Machine & Tool Works, Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pond Machine Tool Co., Plainfield, N. J
Pratt & Whitney Co., Hartford, Conn.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
R. D. Wood & Co., Philadelphia, Pa.

Quarrying Machinery.

Broderick & Bascom Rope Co., St. Louis, Mo.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., New York City.
John H. McGowan Co., Cincinnati, Ohio.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Works Co., Toledo, Ohio.

Radiators.

John Simmons Co., 110 Centre St., New York.
H. B. Smith Co., 137 Centre St., New York.

Racks—Machine Cut.

R. D. Nuttall Co., Pittsburg, Pa.

Rail Braces.

Continuous Rail Joint Co. of Am., Century Bldg., Newark, N. J.

Rail Drill.

Railway Appliances Co. Old Colony Bldg., Chicago, Ill.

Railway Forgings.

B. M. Jones & Co., 150 Devonshire St., Boston, Mass.
Railway Appliances Co. Old Colony Bldg., Chicago, Ill.

Railway Shop Machinery.

Chester B. Albree, Allegheny, Pa.
W. F. & John Barnes Co., Rockford, Ill.
Cleveland Punch & Shear Works Co., Cleveland, O.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Hilles & Jones Co., Wilmington, Del.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Frank Machinery Co., Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Norwalk Iron Works, South Norwalk, Conn.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
H. B. Underwood & Co., 1025 Hamilton St., Philadelphia, Pa.
Watson-Stillman Co., 46 Dey St., New York.

Railway Specialties.

Continental Car & Equipment Co., Whitehall Bldg., New York.
Continuous Rail Joint Co. of Am., Century Bldg., Newark, N. J.
C. W. Hunt Co., West New Brighton, N. Y.
Arthur Koppel, 68 Broad St., New York.
H. K. Porter Co., Pittsburg, Pa.
Railway Appliances Co. Old Colony Bldg., Chicago, Ill.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Air Brake Co., Pittsburg, Pa.

Reamers.

Standard Tool Co., Cleveland, Ohio.

Refrigerating Machinery—SEE ICE-MAKING MACHINERY.

Rheostats.

The Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Simplex Electric Heating Co., Cambridge, Mass.

Riveting Machines.

Chester B. Albree, Allegheny, Pa.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Thos. H. Dallett Co., Philadelphia, Pa.
Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Hanna Eng'ng Works, 820 Elston Ave., Chicago, Ill.
Hilles & Jones Co., Wilmington, Del.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
The National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Rand Drill Co., 128 Broadway, New York.
R. D. Wood & Co., Philadelphia, Pa.

Rivet-Making Machinery.

Howard Iron Works, Buffalo, N. Y.
National Machinery Co., Tiffin, O.

Road-Making Machinery.

Vulcan Iron Works, Toledo, Ohio.

Rock Breakers.

Allis-Chalmers Co., Chicago, Ill.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 39 Cortlandt St., New York.
E. H. Stroud & Co., Chicago, Ill.
Sturtevant Mill Co., Boston, Mass.

Rolling Mill Machinery.

Diamond Drill & Machine Co., Birdsboro, Pa.
A. Garrison Foundry Co., Pittsburg, Pa.
Kenworthy Engineering & Construction Co., Waterbury, Conn.
Morgan Construction Co., Worcester, Mass.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Poole Engineering & Machine Co., Baltimore, Md.
Quincy Engine Works, Quincy, Ill.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Rolls, Chill and Sand.

Cleveland Punch & Shear Works, Cleveland, Ohio.
A. Garrison Foundry Co., Pittsburg, Pa.

Roofing.

Paraffine Paint Co., San Francisco, Cal.
Standard Paint Co., 100 William St., New York.

Roofing Paints and Varnish.

Paraffine Paint Co., San Francisco, Cal.
Standard Paint Co., 100 William St., New York.

Rope-Hoisting and Hauling.

A. Leschen & Sons Rope Co., St. Louis, Mo.

Rope Transmission.

Broderick & Bascom Rope Co., St. Louis, Mo.
H. W. Caldwell & Sons Co., Chicago, Ill.
Crocker-Wheeler Co., Ampere, N. J.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Providence Engineering Works, Providence, R. I.

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Rubber Goods.
Boston Belting Co., Boston, Mass.
Jenkins Bros., 71 John St., New York.

Rubber Washing Machinery.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Sand Blast.
J. W. Paxson Co., Philadelphia, Pa.

Sand Mixers and Sifters.
Hanna Eng'ng Works, 820 Elston Ave., Chicago, Ill.

Saw-Mill Machinery.
Allis-Chalmers Co., Chicago, Ill.
A. F. Bartlett & Co., Saginaw, Mich.
Curtis & Co. Mfg. Co., St. Louis, Mo.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Frank Machinery Co., Buffalo, N. Y.
Vulcan Iron Works, San Francisco, Cal.

Saws, Metal.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Hoefer Mfg. Co., 100 Chicago St., Freeport, Ill.

Scales and Balances.
F. W. Braun Co., Los Angeles, Cal.

Screens, Mining.
Allis-Chalmers Co., Chicago, Ill.
Henshaw, Bulkley Co., San Francisco, Cal.
Jeffrey Mfg. Co., Columbus, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
W. S. Tyler Co., Cleveland, Ohio.

Screens, Rolled Slot.
W. S. Tyler Co., Cleveland, Ohio.

Screw Machines.
Jones & Lamson Machine Co., Springfield, Vt.
National-Acme Mfg. Co., Cleveland, O.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.

Separators, Steam and Oil.
Allis-Chalmers Co., Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
Austin Separator Co., Detroit, Mich.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Goubert Mfg. Co., 85 Liberty St., New York.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Loew Supply & Mfg. Co., Cleveland, Ohio.
Watson & McDaniel Co., Philadelphia, Pa.

Sewer Pipe Presses and Dies (Clay).
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Shafting—SEE PULLEYS.

Shapers.
American Tool Works Co., Cincinnati, Ohio.
Frank Machinery Co., Buffalo, N. Y.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.
John Steptoe Shaper Co., Cincinnati, O.
Stockbridge Machine Co., Worcester, Mass.

Shears—SEE PUNCHING MACHINERY.

Sheet Metal Work.
Globe Machine & Stamping Co., Cleveland, Ohio.
Lyon Metallic Mfg. Co., 18 S. Ann St., Chicago, Ill.

Ship Builders' Machinery.
Cleveland Punch & Shear Works Co., Cleveland, O.

Shutters (Fire).
Coburn Trolley Track Mfg. Co., Holyoke, Mass.

Shutters, Steel Rolling.
Kinnear Mfg. Co., Columbus, Ohio.

Silicate Stone.
Silicate Stone Co., 15 Wall St., New York.

Skylights and Ventilators.
G. Drouvé & Co., Bridgeport, Conn.
Josephus Plenty, Jersey City, N. J.

Special Machinery.
Globe Machine & Stamping Co., Cleveland, Ohio.
P. Hollingsworth Morris, 1501 S. Front St., Philadelphia, Pa.
Russel Wheel & Foundry Co., Detroit, Mich.

Speed Controllers.
Foster Engineering Co., Newark, N. J.
Power & Speed Controller Co., 147 Milk St., Boston, Mass.

Spike Machines.
National Machinery Co., Tiffin, Ohio.

Spiral Gears.
R. D. Nuttall Co., Pittsburg, Pa.

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Schwerdtle Stamp Co., Bridgeport, Conn.

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Wm. B. Pollock Co., Youngstown, Ohio.
Struthers-Wells Co., Warren, Pa.
Tippett & Wood, Phillipsburg, Pa.

Steam Engine Indicators.
Star Brass Mfg. Co., Boston, Mass.

Steam-Regulating Appliances.
American Steam Gauge & Valve Co., Boston, Mass.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
G. M. Davis Regulator Co., 141 Milwaukee Ave., Chicago, Ill.
Julian D'Este Co., 24 Canal St., Boston, Mass.
Foster Engineering Co., Newark, N. J.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Jenkins Brothers, 71 John St., New York.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
Power Specialty Co., 126 Liberty St., New York.
John Simmons Co., 110 Centre St., New York.
Tracy Engineering Co., San Francisco, Cal.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Williams Gauge Co., W. Pittsburg, Pa.

Steam Pile Hammers.
A. F. Bartlett & Co., Saginaw, Mich.

Steam Separators.
Austin Separator Co., Detroit, Mich.
Harrison Safety Boiler Works, 3138 No. Seventeenth St., Philadelphia, Pa.

Steam Shovels.
Bucyrus Co., So. Milwaukee, Wis.
C. W. Hunt Co., West New Brighton, N. Y.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.

Steam Specialties.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Ashton Valve Co., Boston, Mass.
Austin Separator Co., Detroit, Mich.
Crane Co., Chicago, Ill.
G. M. Davis Regulator Co., 141 Milwaukee Ave., Chicago, Ill.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Foster Engineering Co., Newark, N. J.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
Power Specialty Co., 126 Liberty St., New York.
John Simmons Co., 110 Centre St., New York.
Tracy Engineering Co., San Francisco, Cal.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wright Mfg. Co., Detroit, Mich.

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Power Specialty Co., 126 Liberty St., New York.

Steam Traps.
American Blower Co., Detroit, Mich.
G. M. Davis Regulator Co., 144 Milwaukee Ave., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
John Simmons Co., 110 Centre St., New York.
B. F. Sturtevant Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wright Mfg. Co., Detroit, Mich.

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Steel.
Wm. Jessop & Sons, Ltd., 91 John St., New York.
B. M. Jones & Co., 150 Devonshire St., Boston, Mass.
Latrobe Steel Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Steel Axles.
B. M. Jones & Co., 150 Devonshire St., Boston, Mass.

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American Ball Co., Providence, R. I.
Federal Mfg. Co., Cleveland, O.
Hess-Bright Co., Philadelphia, Pa.

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Latrobe Steel Co., 1200 Girard Bldg., Phila., Pa.

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Latrobe Steel Co., 1200 Girard Bldg., Phila., Pa.

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Lyon Metallic Mfg. Co., 18 S. Ann St., Chicago, Ill.
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Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Stencils.
Schwerdtle Stamp Co., Bridgeport, Conn.

Stokers—Mechanical.
Babcock & Wilcox Co., 85 Liberty St., New York.
Cahall Sales Department, Pittsburg, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Stone.
Silicate Stone Co., 15 Wall St., New York.

Structural Iron Work.
Chester B. Albree, Allegheny, Pa.
American Bridge Co., 100 Broadway, N. Y.
Berlin Construction Co., Berlin, Conn.
Browning Engineering Co., Cleveland, Ohio.
Interstate Engineering Co., Cleveland, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

Structural Steel Work.
Russel Wheel & Foundry Co., Detroit, Mich.

Sugar-House Machinery.
American Tool & Machine Co., Boston, Mass.
P. Hollingsworth Morris, 1501 S. Front St., Philadelphia, Pa.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Union Steam Pump Co., 44 So. Madison St., Battle Creek, Mich.
R. D. Wood & Co., Philadelphia, Pa.

Tanks, Iron.
Allis-Chalmers Co., Chicago, Ill.
Atlantic Works, East Boston, Mass.
Flint & Walling Mfg. Co., Kendallville, Md.
L. O. Koven & Brother, 50 Cliff St., New York.
Wm. B. Pollock Co., Youngstown, Ohio.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Struthers-Wells Co., Warren, Pa.
Tippett & Wood, Phillipsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.

Tanks.
W. E. Caldwell Co., Louisville, Ky.
Flint & Walling Mfg. Co., Kendallville, Md.
Kenworthy Engineering & Construction Co., Waterbury, Conn.
Lacy Mfg. Co., 334 N. Main St., Los Angeles, Cal.

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W. J. Clark Co., Salem, Ohio.

Taps and Dies.
Crane Co., Chicago.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.

Tappers.
Howard Iron Works, Buffalo, N. Y.

Tapping and Reaming Machines.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.

Telephones.
Ericsson Telephone Co., 296 Broadway, New York

Tenoning Machines.
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Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.

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American Railway Supply Co., 24 Park Place, N. Y.
Schwerdtle Stamp Co., Bridgeport, Conn.

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E. Howard Clock Co., 401 Washington St., Boston, Mass.

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Diamond Drill & Machine Co., Birdsboro, Pa.
E. H. Stroud & Co., Chicago, Ill.

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Latrobe Steel Co., Philadelphia, Pa.

Tracing Cloth.
Kolesch & Co., 138 Fulton St., New York.

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A. Leschen & Sons Rope Co., St. Louis, Mo.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.

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Coburn Trolley Track Mfg. Co., Holyoke, Mass.
Hayden & Derby Mfg. Co., New York.
Hayward Co., 97 Cedar St., New York.
Interstate Engineering Co., Cleveland, Ohio.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Shaw Electric Crane Co., Muskegon, Mich.
Frank B. Stratford, 95 Liberty St., New York.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

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Coburn Trolley Track Mfg. Co., Holyoke, Mass.

Trucks, Motor.
Gibbs Engineering Co., 43 Exchange Place, N. Y. City.

Tumbling Barrels.
Globe Machine & Stamping Co., Cleveland, Ohio.

Turnbuckles.
John Simmons Co., 110 Centre St., New York.

Turn Tables.
Arthur Koppel, 68 Broad St., New York.
Russel Wheel & Foundry Co., Detroit, Mich.
Tippett & Wood, Phillipsburg, Pa.

Turret Lathes.
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American Tool Works Co., Cincinnati, Ohio.
Bullard Machine Tool Co., Box 1055 Bridgeport, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Niles-Bement-Pond Co., 136 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.

Twist Drills.
Standard Tool Co., Cleveland, Ohio.

Vacuum and Draft Gauges.
Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.

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Vacuum Pumps.
Alberger Condenser Co., 95 Liberty St., New York.
Clayton Air-Compress. Wks., 114 Liberty St., N. Y.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Guild & Garrison, Brooklyn, N. Y.
John H. McGowan Co., Cleveland, Ohio.
Union Steam Pump Co., 44 So. Madison St., Battle Creek, Mich.

Valves—Gas, Steam, and Water.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Boston Belting Co., Boston, Mass.
Consolidated Safety Valve Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
G. M. Davis Regulator Co., 141 Milwaukee Ave., Chicago, Ill.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Detroit Leather Specialty Co., Detroit, Mich.
Foster Engineering Co., Newark, N. J.
Jenkins Bros., 71 John St., New York.
Kennedy Valve Mfg. Co., 70 Beekman St., N. Y.
John H. McGowan Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., 52 John St., New York.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
Ross Valve Co., Troy, N. Y.
John Simmons Co., 110 Centre St., New York.
Star Brass Mfg. Co., Boston, Mass.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.

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John Simmons Co., 110 Centre St., New York.

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American Well Works, Aurora, Ill.
Bacon Air Lift Co., 92 William St., New York.
Clayton Air Compress. Wks., 114 Liberty St., N. Y.
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Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
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New York Continental Jewell Filtration Co., 15 Broad St., New York.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

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Abner Doble Co., 200 Fremont St., San Francisco, Cal.
Dayton Globe Iron Works Co., Dayton, O.
Pelton Water Wheel Co., San Francisco, Cal.
Poole Engineering & Machine Co., Baltimore, Md.
Power Specialty Co., 126 Liberty St., New York.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Water-Wheel Governors.
Lombard Governor Co., Boston, Mass.
Woodward Governor Co., Rockford, Ill.

Water-Works Pumping Machinery.
Allis-Chalmers Co., Chicago, Ill.
Bacon Air Lift Co., 92 William St., New York.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Robt. Wetherill & Co., Chester, Pa.
R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 118 Liberty St., New York.

Water-Works Supplies.
American Well Works, Aurora, Ill.
W. E. Caldwell Co., Louisville, Ky.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Power Specialty Co., 126 Liberty St., New York.
John Simmons Co., 110 Centre St., New York.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Wells—Artesian.
Bacon Air Lift Co., 92 William St., New York.

Well Supplies.
American Diamond Rock Drill Co., 95 Liberty St., New York.
American Well Works, Aurora, Ill.
Detroit Leather Specialty Co., Detroit, Mich.
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Wheelbarrows.
G. L. Stuebner Iron Works, Long Island City, N. Y.

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Wire Cloth and Screen.
W. S. Tyler Co., Cleveland, Ohio.

Wire-Drawing Machinery.
Hoefer Mfg. Co., 100 Chicago St., Freeport, Ill.
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Wire, Insulated—SEE INSULATED WIRE.

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Clinton Fireproofing System, 150 Nassau St., N. Y.
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A. Leschen & Sons Rope Co., St. Louis, Mo.
Trenton Iron Co., Trenton, N. J.

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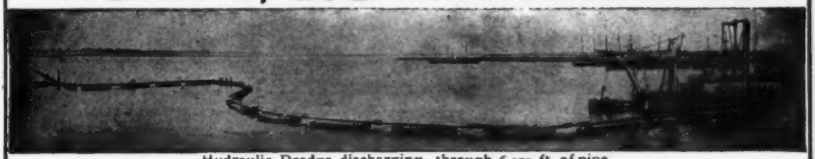

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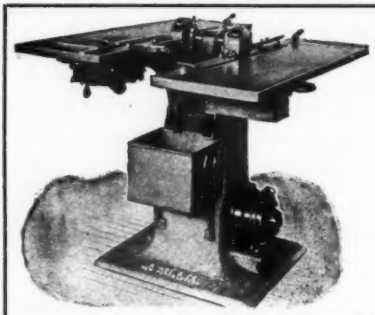

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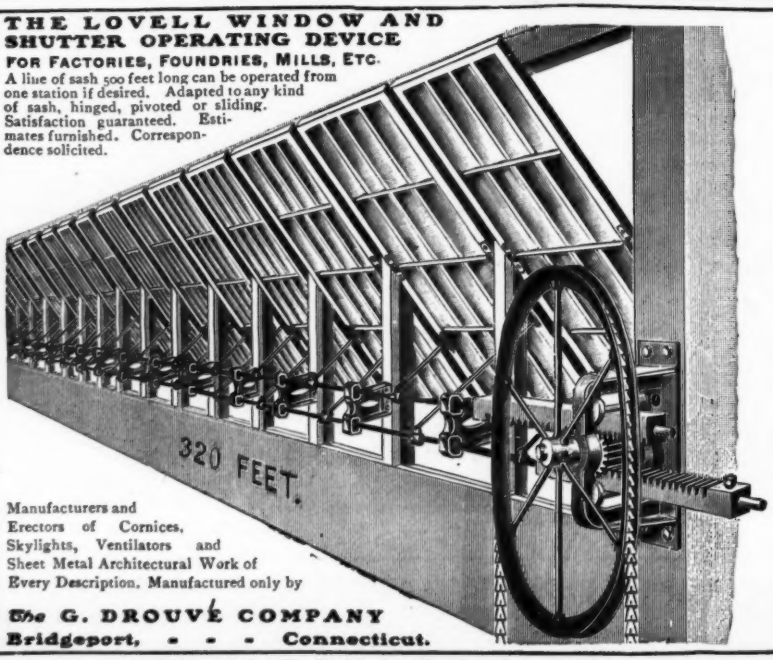

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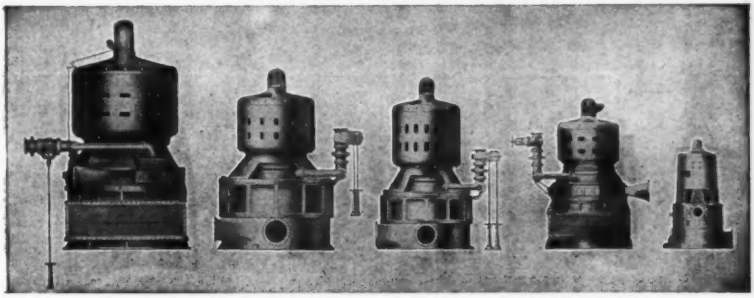

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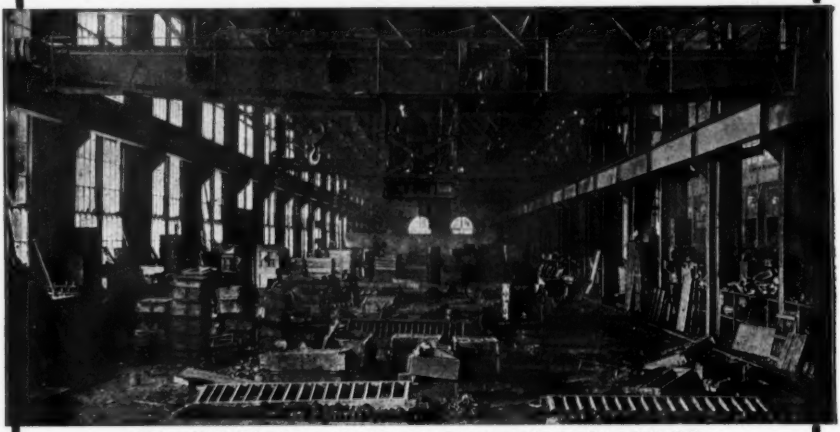

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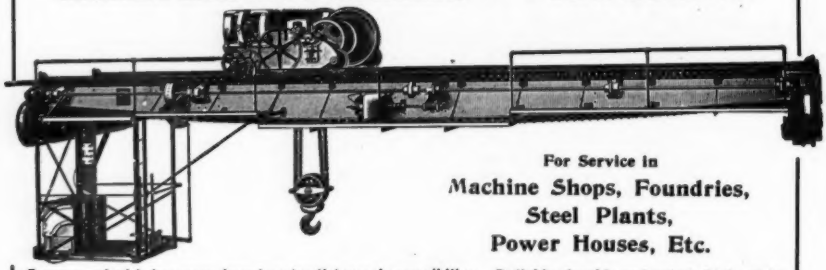

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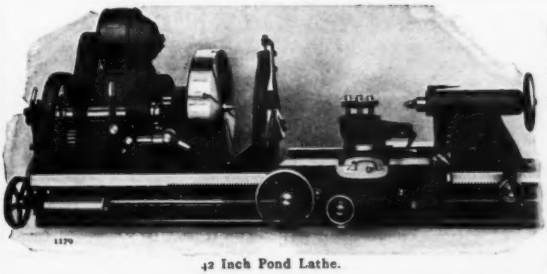

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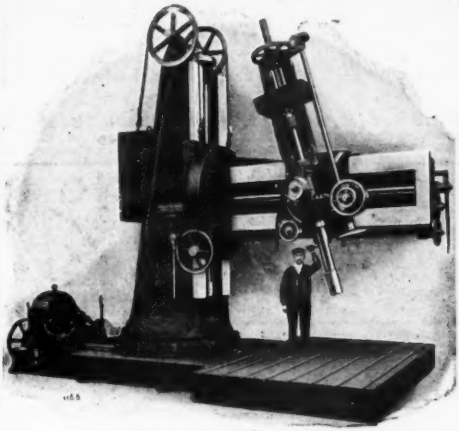

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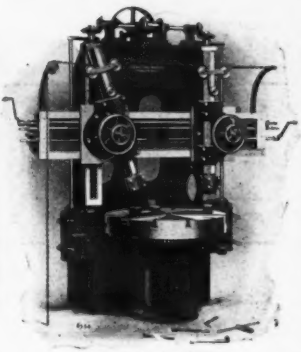

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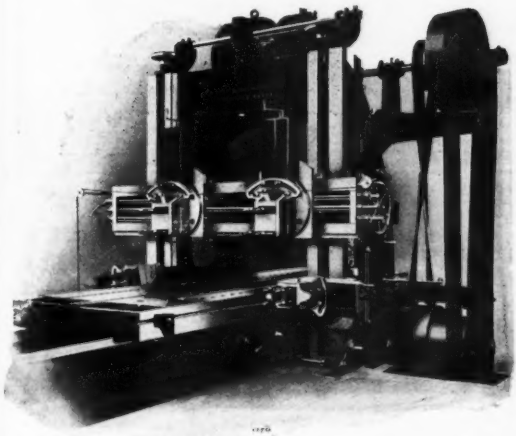

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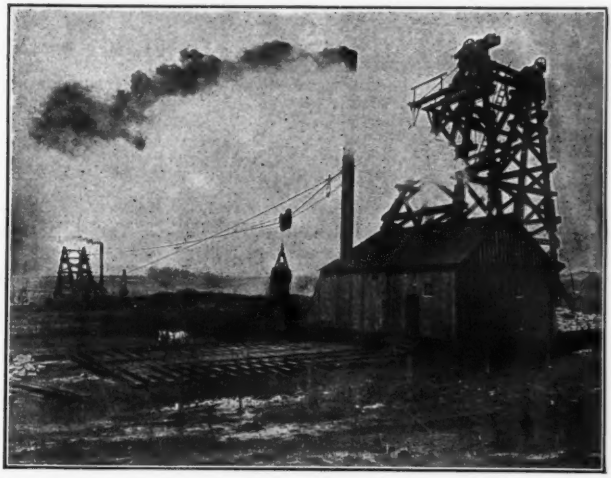

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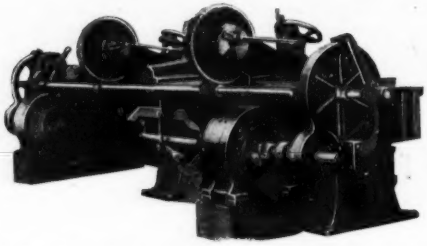

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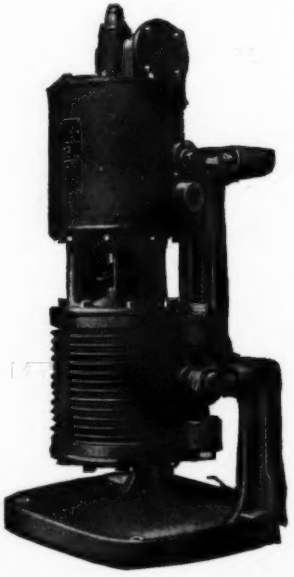

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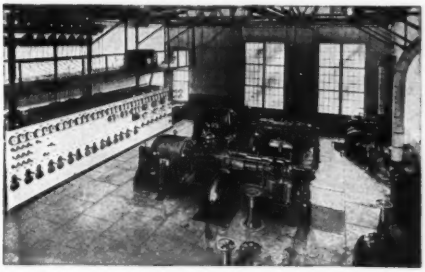

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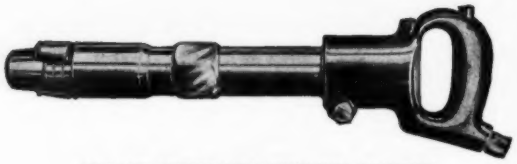

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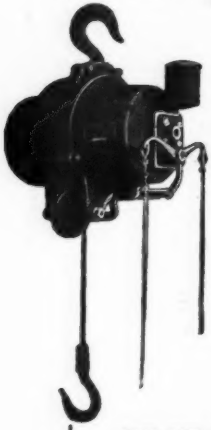

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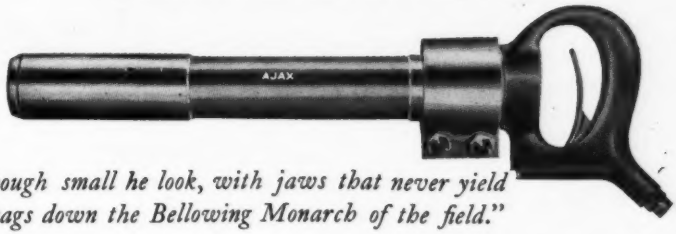

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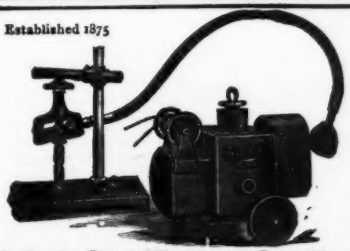

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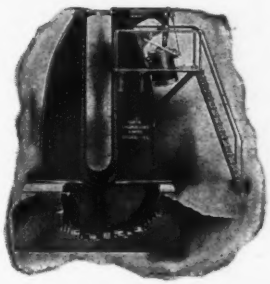

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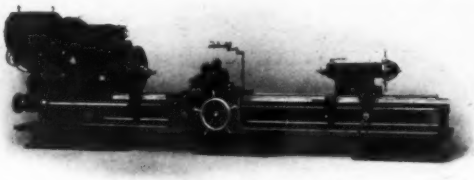

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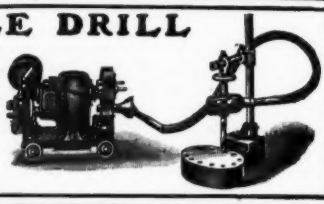

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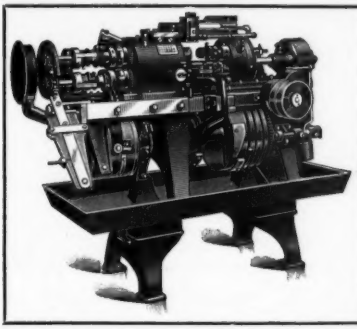

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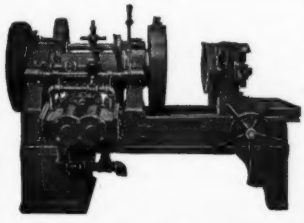

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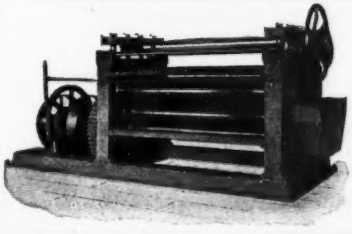

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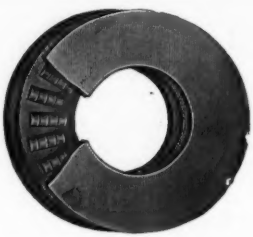

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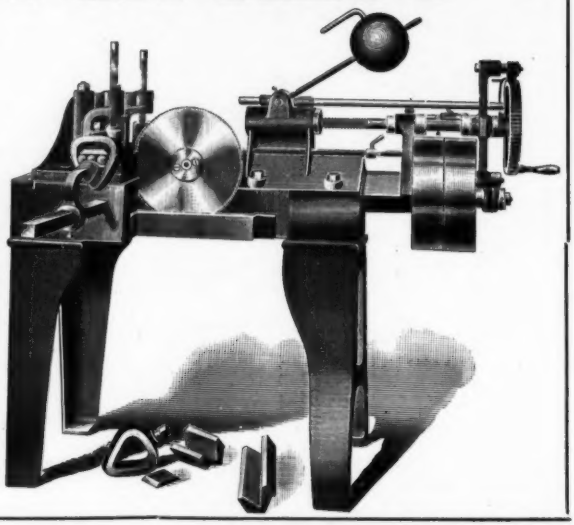

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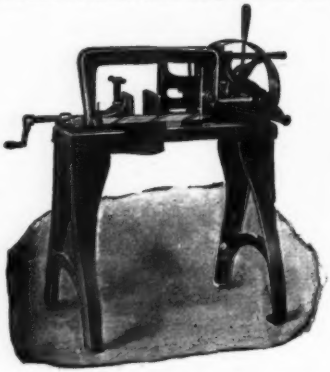

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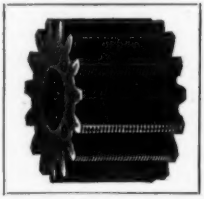

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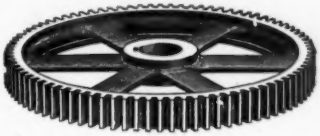

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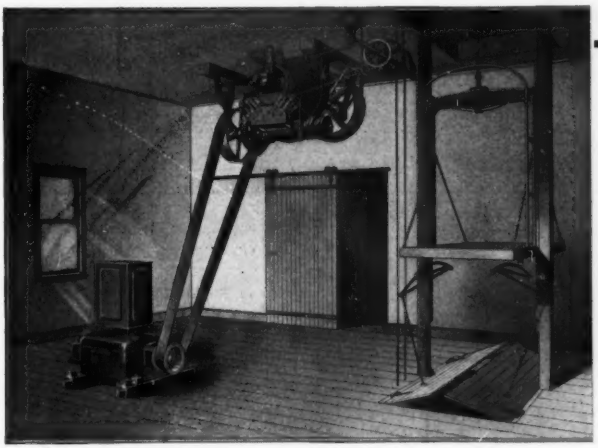

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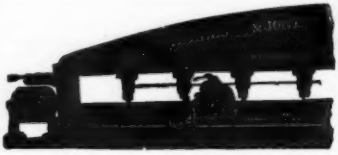

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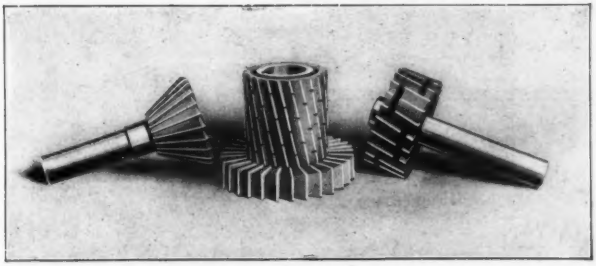

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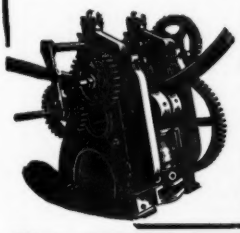

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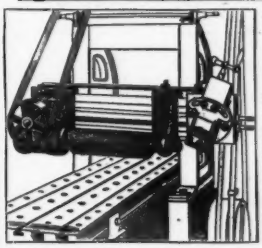

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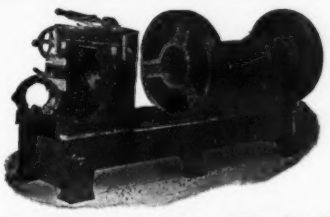

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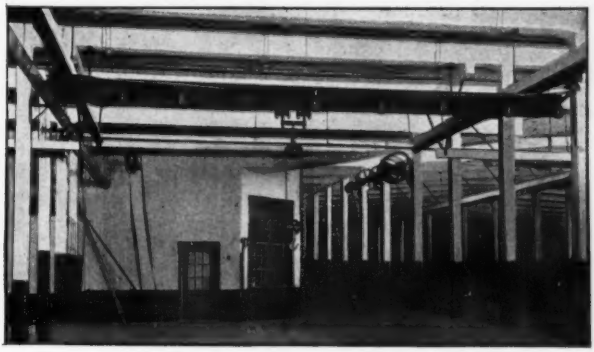

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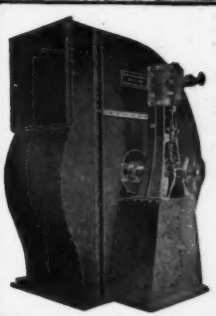

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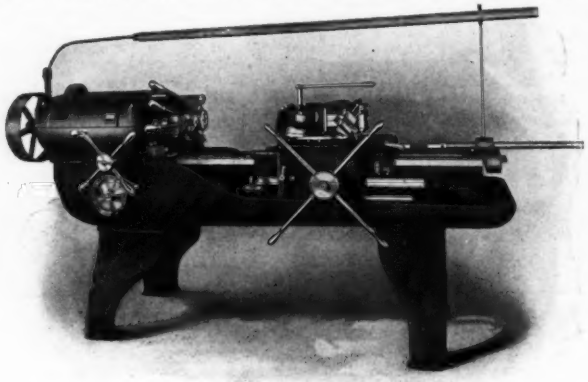

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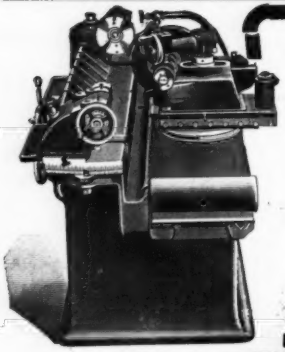

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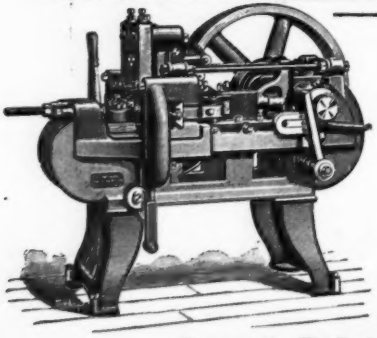

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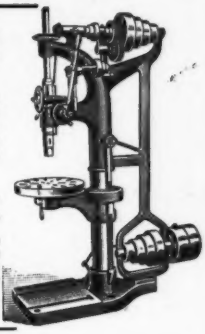

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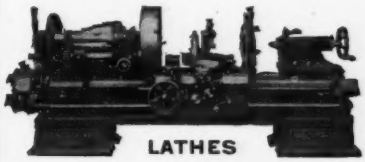

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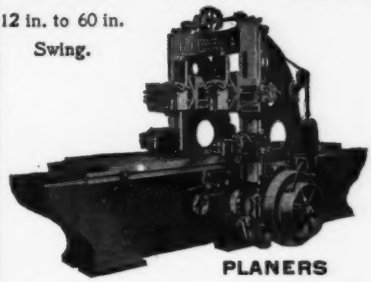

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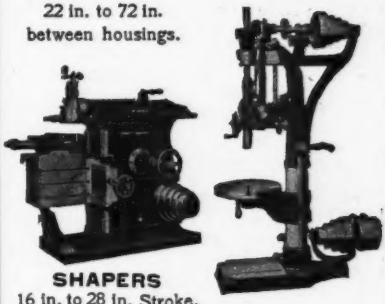

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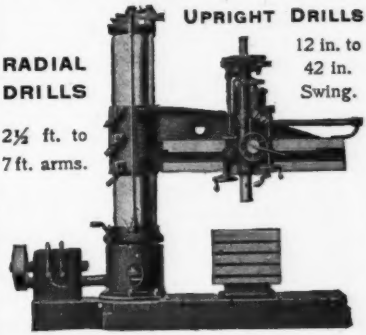

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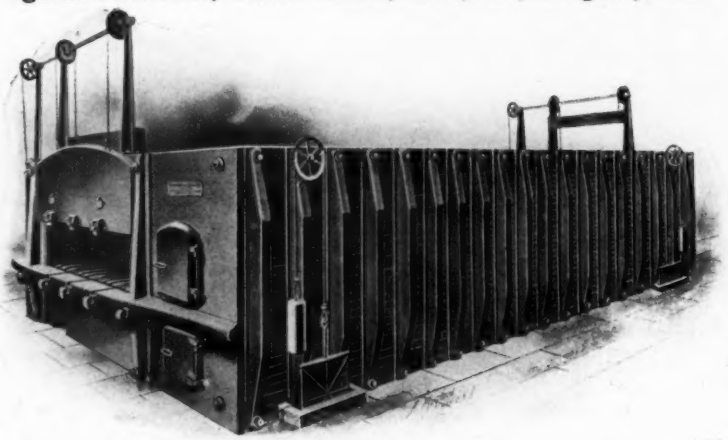

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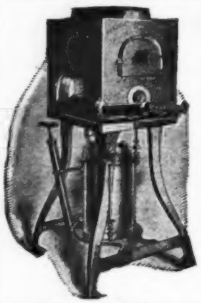

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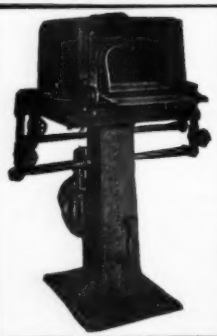

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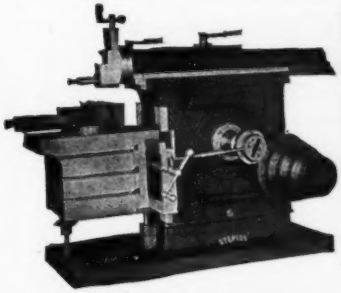

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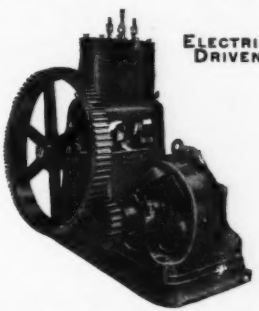

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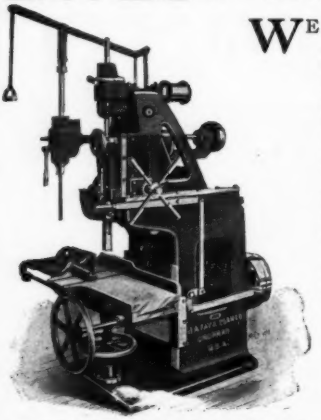

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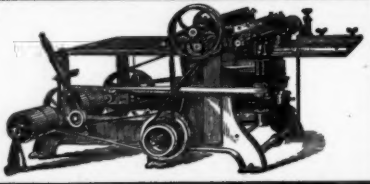

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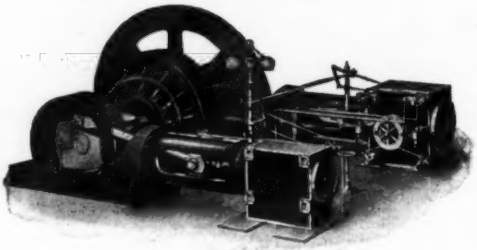

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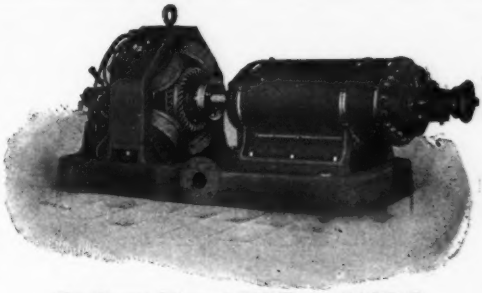

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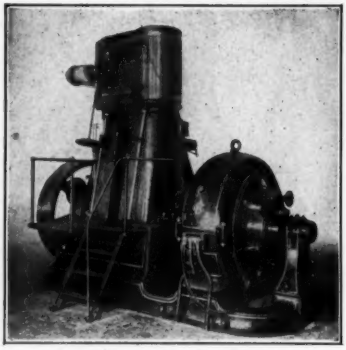

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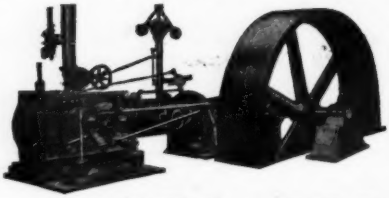

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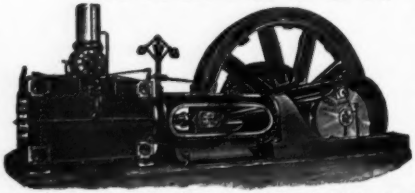

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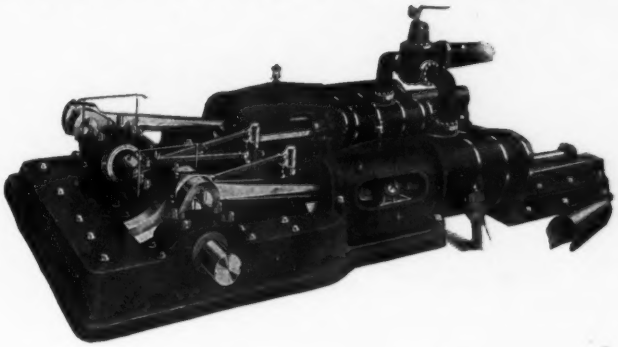

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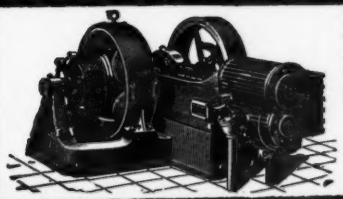

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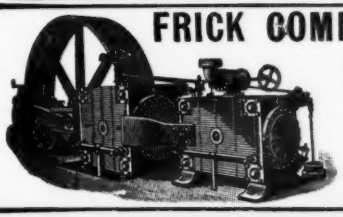

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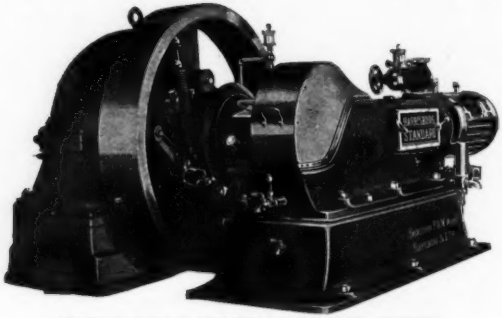

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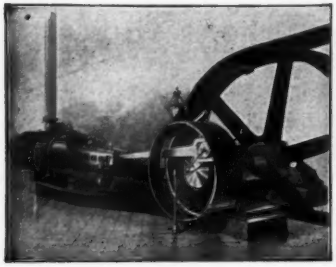

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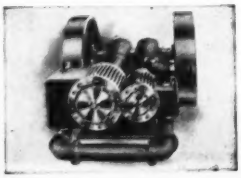

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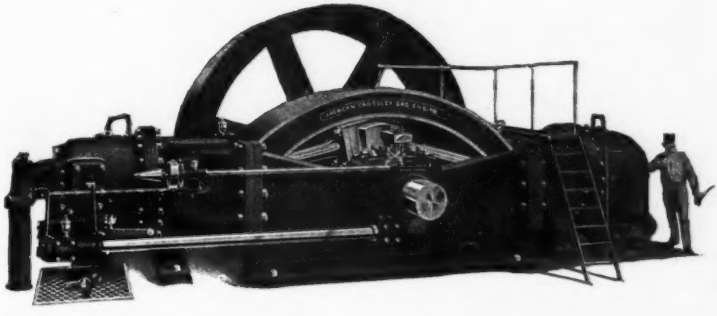

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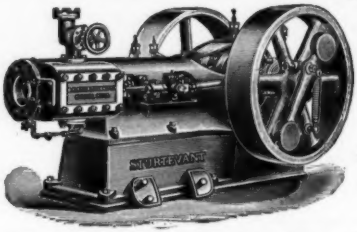

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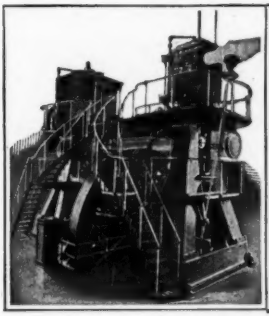

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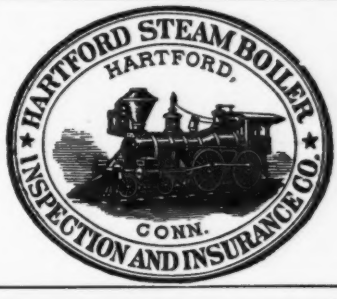

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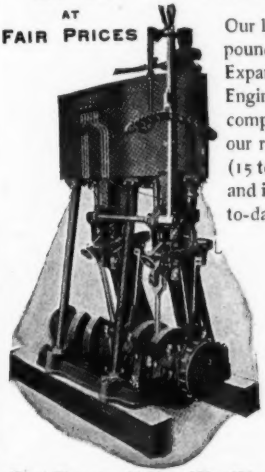

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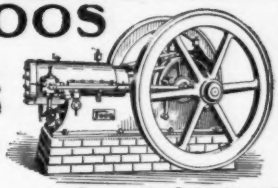

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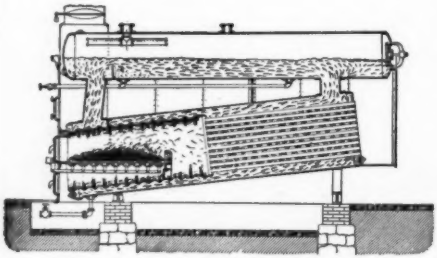

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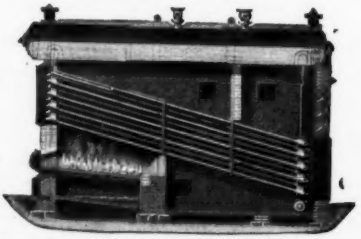

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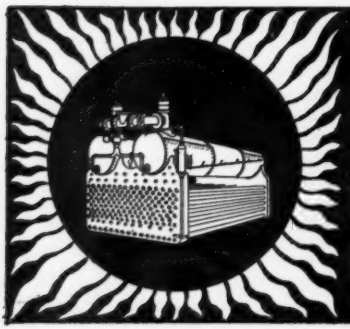

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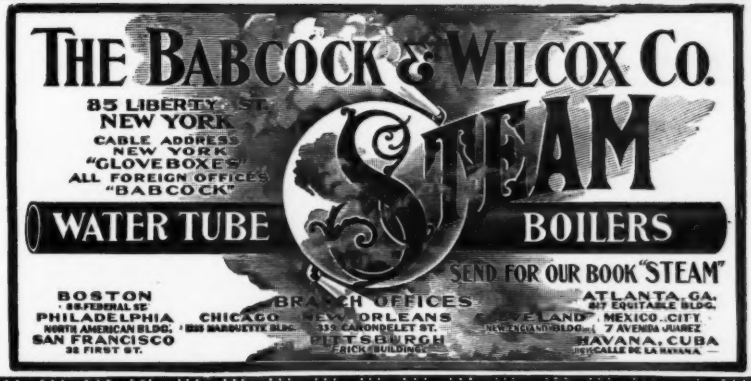
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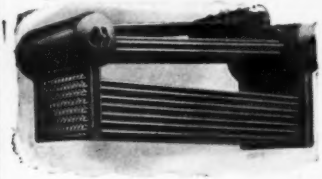

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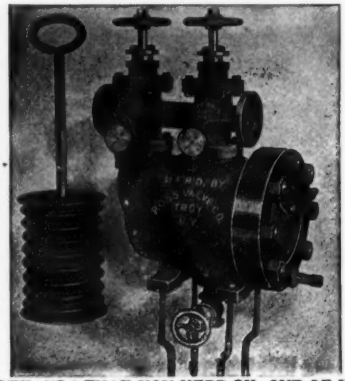

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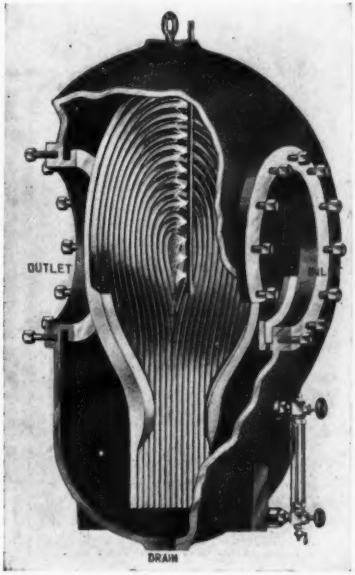

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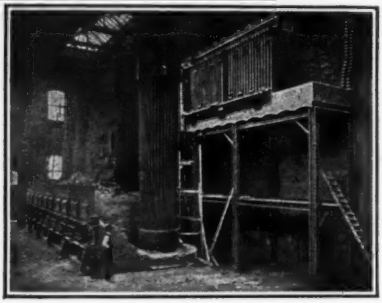

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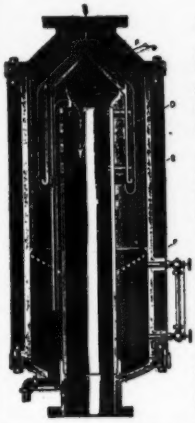

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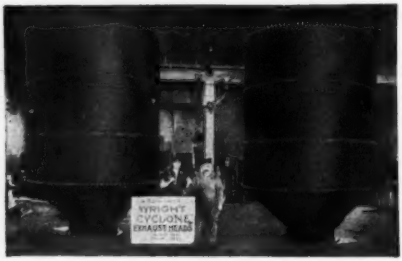

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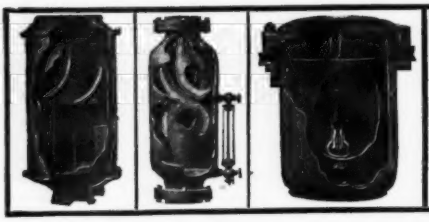

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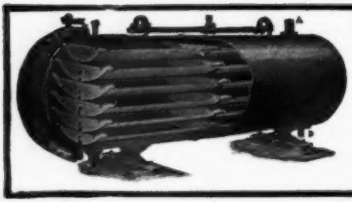

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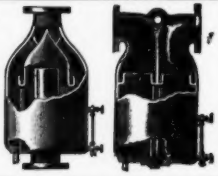

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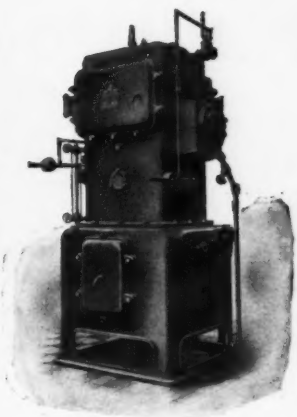

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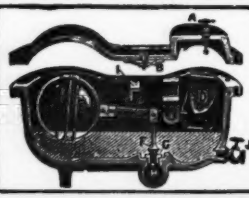

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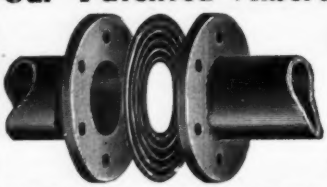

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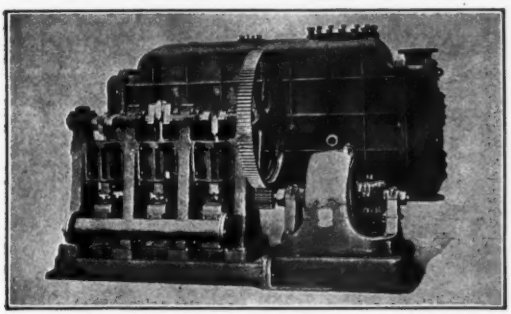

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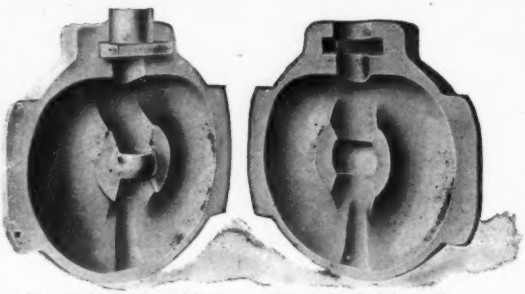

Showing back of disc with stem nut and center piece in place.

Showing back of disc and bearing for center piece.

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FIG. 310

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Dimensions Iron Body Flanged Gate Valves.

Size ..... Inches	2	2½	3	3½	4	4½	5	6	7	8	10	12
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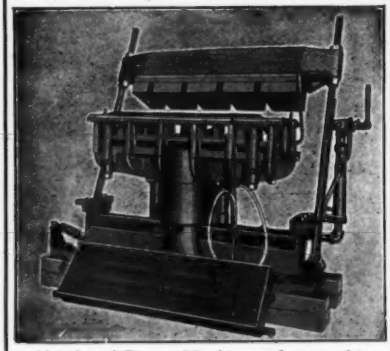

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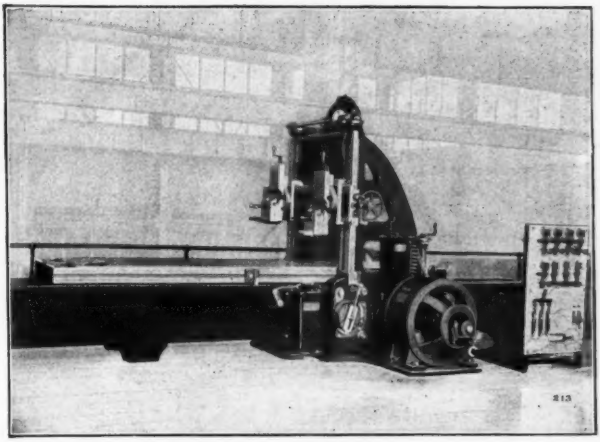

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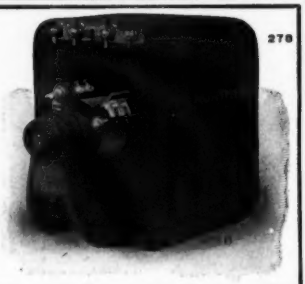

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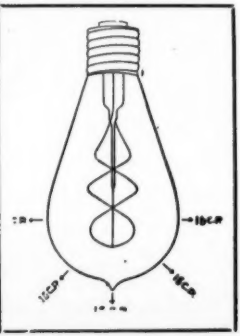

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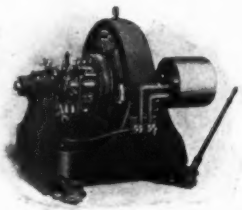

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WHITNEY INSTRUMENTS ENJOINED

Full Opinion of His Honor Judge Wheeler, concurred in by His Honor Judge Lacombe in the case of the

Weston Electrical Instrument Co., Complainant

vs.

Whitney Electrical Instrument Co., Defendant

This suit is brought upon patent No. 392387 dated November 6, 1888, and granted to Edward Weston for an Electrical Measuring Apparatus, which was adjudged to be valid in Weston Electrical Instrument Co. *vs* Jewell Electrical Instrument Co. et al in this Court in March, 1904. It has now been heard upon a motion for a preliminary injunction.

The principal question made now is as to infringement. **The parts of the defendant's instrument look quite differently from the corresponding parts of the instrument of the patent, but notwithstanding these differences in form they are there in the instrument and do the same things in substantially the same way.** This appears quite well from the description of the two instruments in parallel columns in the affidavit of Frank W. Roller, defendant's record on this motion, page 3. The great thing to be done appears to have been to get the movable coil in its diamagnetic frame into a permanent magnetic field, compactly, and to carry the current to be measured from side to side through the coil, and move the coil against steady resistance to measure the current, and record the measurement. Weston seems to have accomplished this by mounting the frame by pivots on non-conducting bridge-pieces, and carrying the current to be measured to and from the movable coil through springs connected with the frame furnishing steady resistance, and a pointer connected with the frame and moving over a scale to show the movement and the measurement of the current.

Any electrical mechanic could provide the permanent magnetic field, and the form of it would not be material except to permit the movement of the frame carrying the coil. The mounting of the frame on the bridge-pieces by pivots with its arrangement and connections was the important part of Weston's patented invention.

The defendant's instruments have the permanent magnetic field provided by a magnet and core of different and perhaps better shapes in some respects, but permitting movement of the frame in an arc of a circle to carry a pointer moving over a scale to indicate the measurement of the current. **If these changes of form are even patentable improvements the defendants have taken and used the invention of the patent in making and using those improvements.**

The difference in the form of the parts carrying the frame on pivots supported by the bridge-pieces is of the same sort. It does not vary the mechanical operation of the parts. **These differences do not, any or all of them, amount to doing the same thing in different ways, but leave the operative parts doing the same thing in the same way.**

According to these views the motion should be granted.

HOYT H. WHEELER,
Judge.

FOR PLAINTIFF:
WILLIAM HOUSTON KENYON.

FOR DEFENDANTS:
CLIFTON V. EDWARDS.

Upon re-examination of the record, I concur in the opinion above expressed by Judge Wheeler.

July 18, 1904.

E. HENRY LACOMBE,
U. S. C. J.

(ENDORSED) Circuit Court of the United States, for the Southern District of New York.—Weston Electrical Instrument Company *vs.* Whitney Electrical Instrument Company *et al.*—Opinion, WHEELER, J.—United States Circuit Court, Southern District of New York. Filed July 20, 1904. John A. Shields, Clerk.

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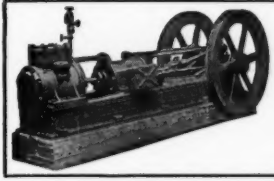

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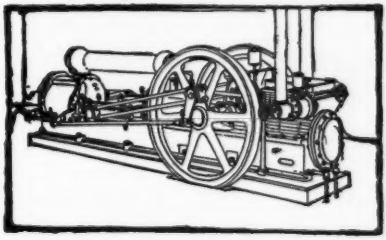

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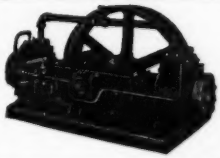

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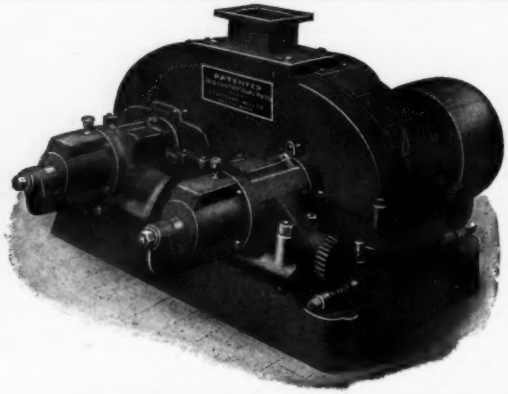

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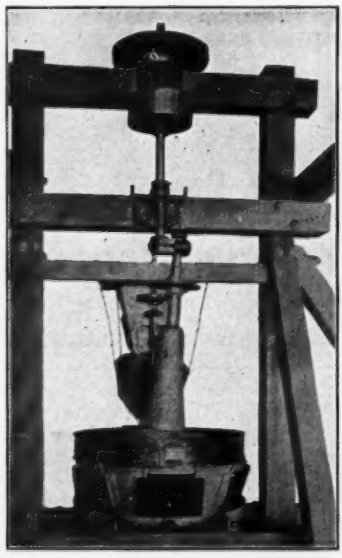

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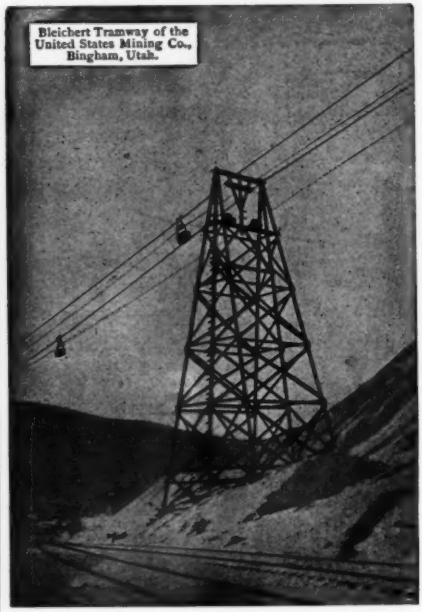
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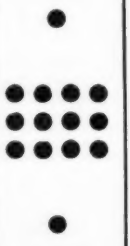

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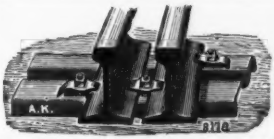

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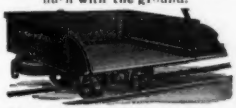

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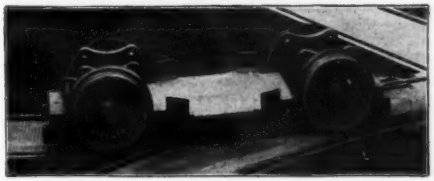

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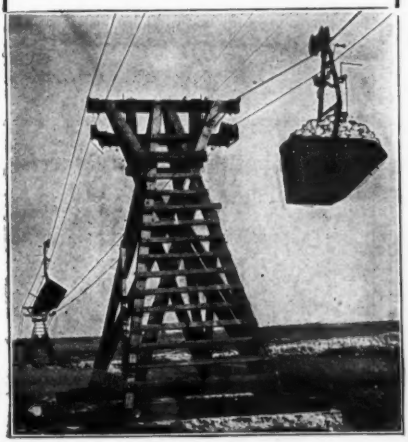

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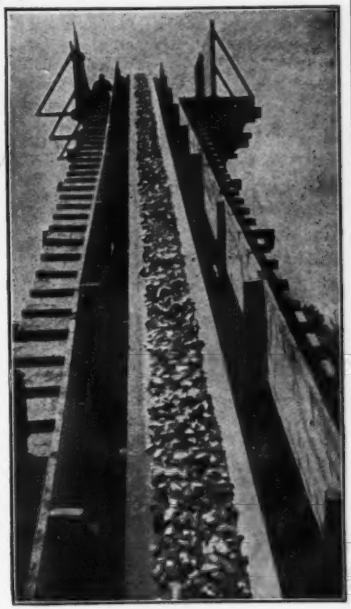

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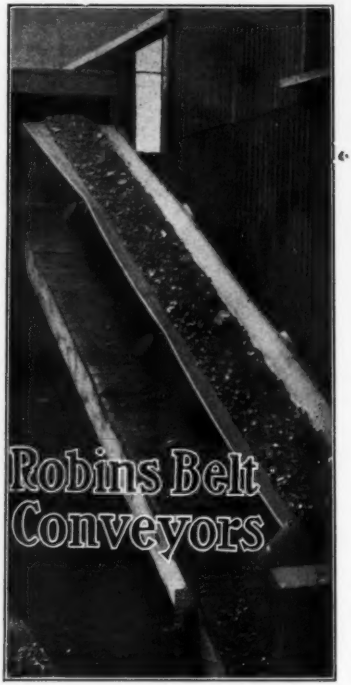

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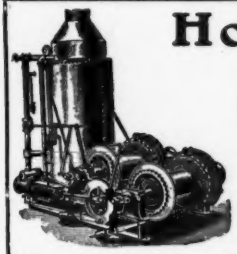

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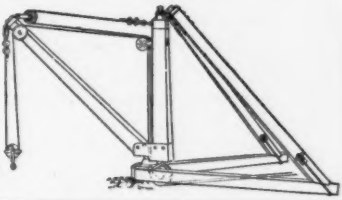

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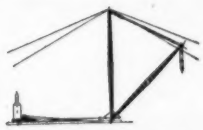

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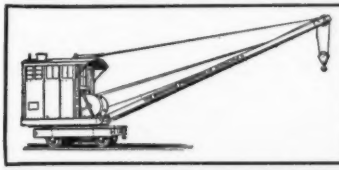

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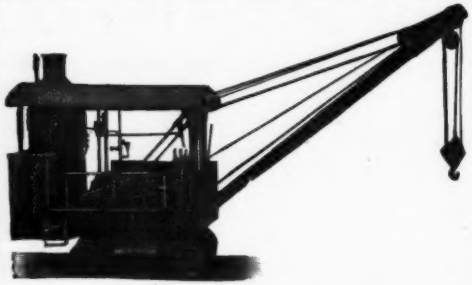

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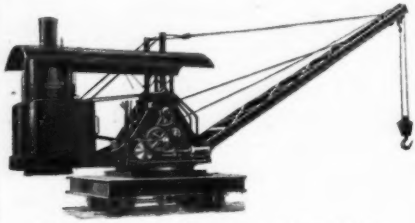

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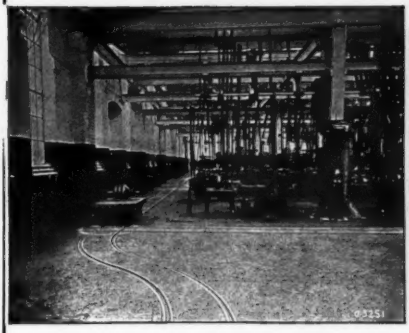

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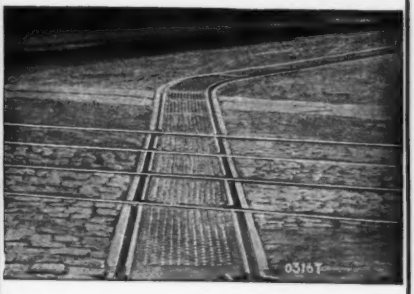

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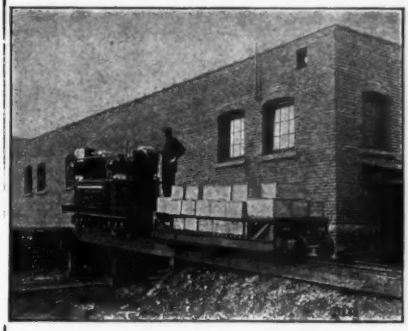

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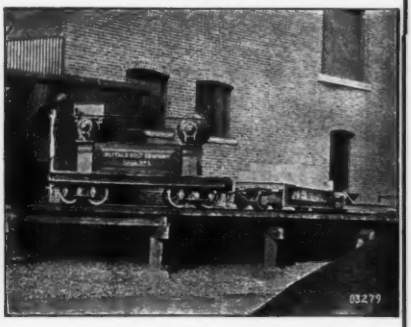

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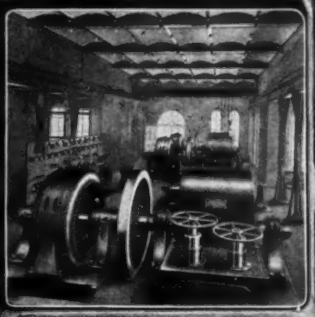

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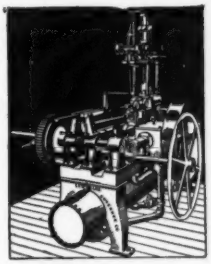

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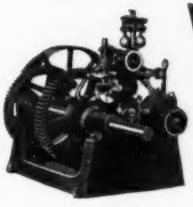

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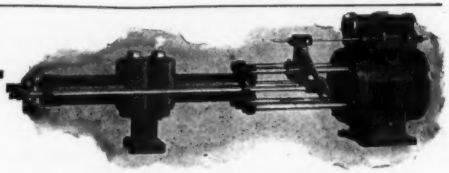

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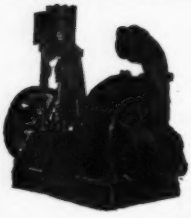

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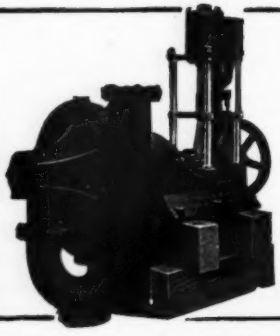

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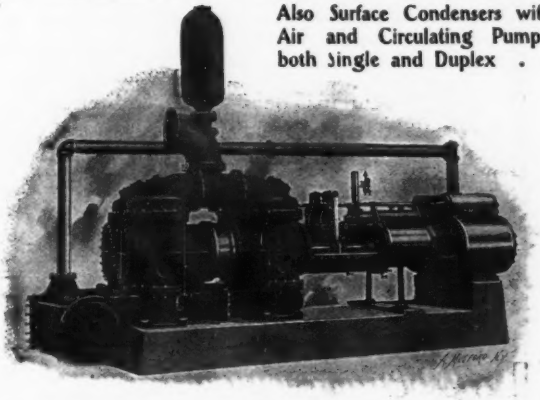

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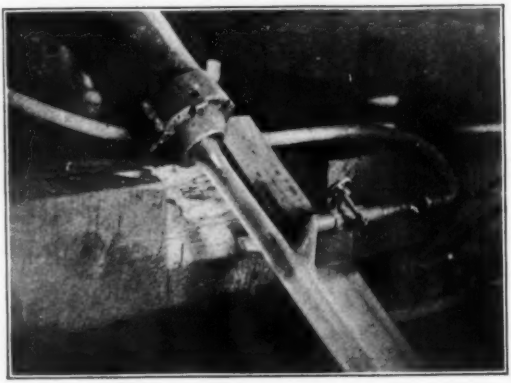

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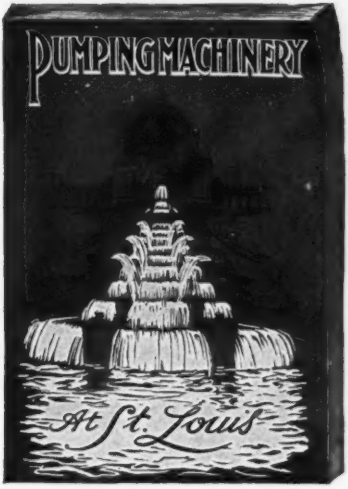

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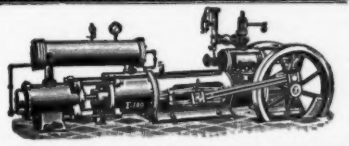

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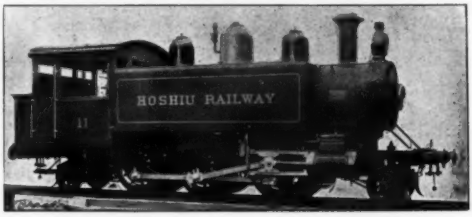

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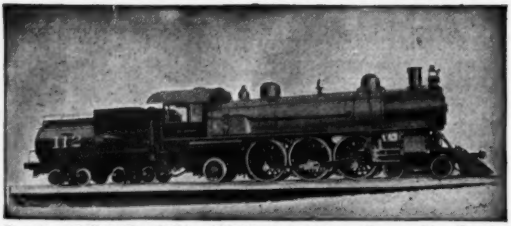

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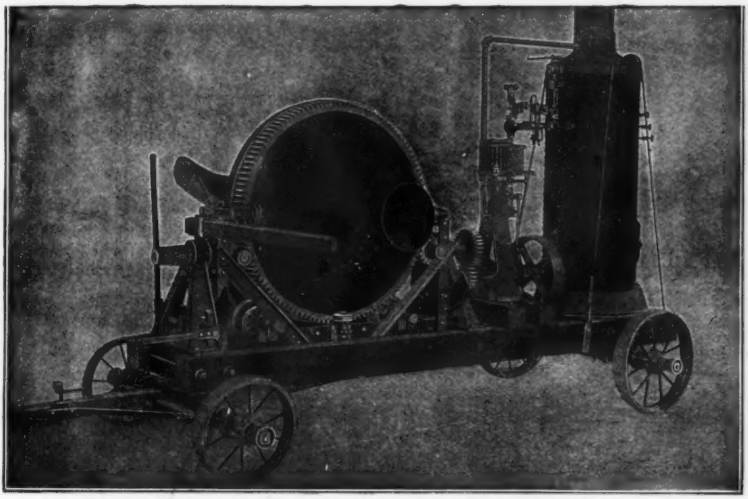

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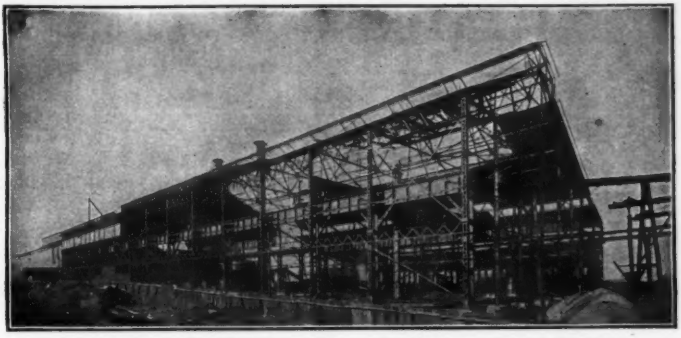

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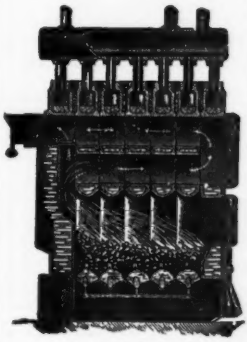

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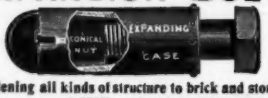

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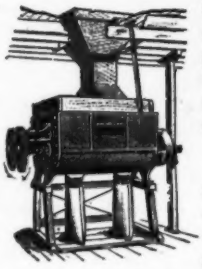

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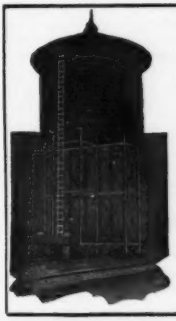

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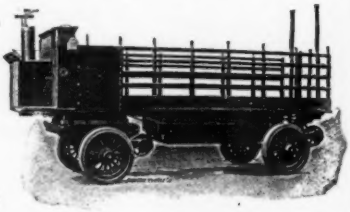

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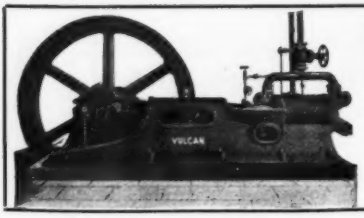

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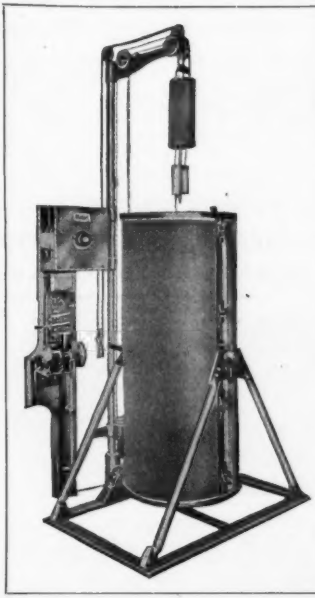

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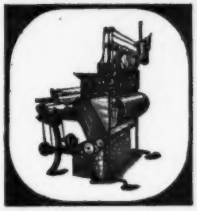

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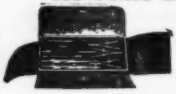

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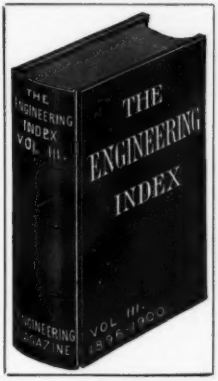

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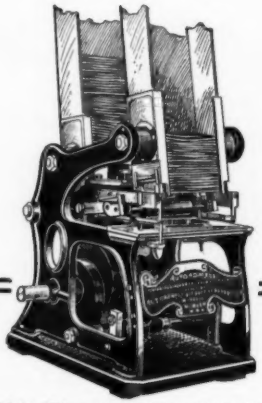

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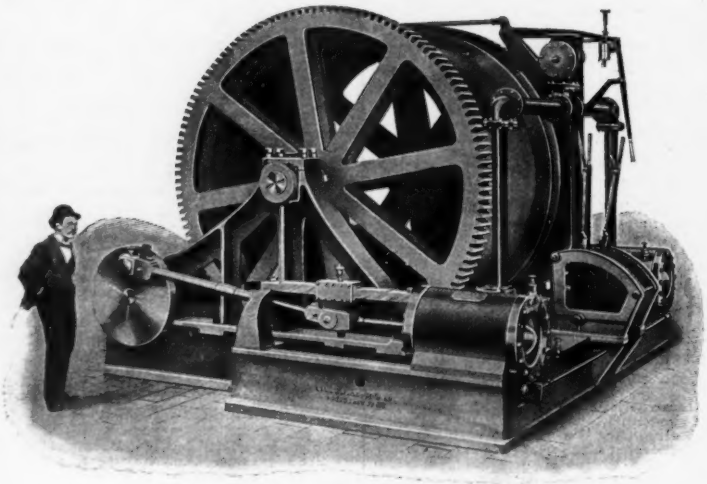

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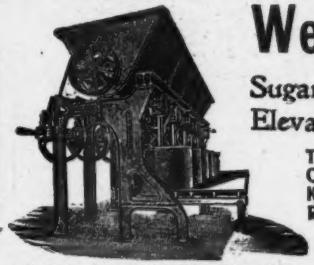

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